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THIRTY-FOURTH ANNUAL REPORT

of

Forage Research

in the

Northeastern United States

1970

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1970

Thirty-Fourth Annual Report

of

Forage Research

in the

Northeastern United States

A Joint Contribution of the

U.S. Regional Pasture Research Laboratory

and the

Agricultural Experiment Stations of the 12 Northeastern States

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Contributing Agencies

Forage and Range Research Branch, Plant Science Research Division

Northeast Branch, Soil and Water Conservation Research Division

Grain and Forage Insects Research Branch, Entomology Research Division

of the

Agricultural Research Service, U.S. Department of Agriculture

and the

Agricultural Experiment Stations of

Connecticut

Delaware

Maine

Maryland

Massachusetts

New Hampshire

New Jersey

New York

Pennsylvania

Rhode Island

Vermont

West Virginia

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TO THE COLLABORATORS:

D. W. Allinson	- Connecticut	W. R. Battle	- New Jersey
W. H. Mitchell	- Delaware	C. C. Lowe	- New York
C. S. Brown	- Maine	R. W. Cleveland	- Pennsylvania
N. A. Clark	- Maryland	B. W. Henderson, Jr.	- Rhode Island
H. Fenner	- Massachusetts	G. M. Wood	- Vermont
G. L. Byers	- New Hampshire	R. L. Reid	- West Virginia

W. I. Thomas - Representative of Northeastern Directors

This Annual Report is intended primarily for use by forage research workers in the Northeastern United States. It contains brief reports of research projects carried on at most of the State Agricultural Experiment Stations in the region, reports from several Regional Project Technical Committees, the U.S. Regional Pasture Research Laboratory and from research personnel of the U.S. Department of Agriculture, Agricultural Research Service at Beltsville, Maryland. Our appreciation is extended to all contributors and to the Collaborator at each station who coordinated the collection of reports.

The format for the Annual Report is similar to that in the past. Only minor changes have been made such as the listing of the roster of forage research workers by individual states and including a listing of graduate students who have received their degrees in forage research during 1970 in the Northeastern states. We have also included a list of contributors and the location of their contribution in the report.

Collaborators appointed during 1970 included Dr. W. R. Battle, New Jersey; Dr. H. Fenner, Massachusetts and Dr. R. L. Reid, West Virginia.

A number of new staff members reported to the U.S. Regional Pasture Research Laboratory during 1970 as replacements for those who retired the previous year. Dr. K. T. Leath served as Acting Director until June 15, 1970. New staff members include:

ROBERT F. BARNES -- Director and Research Agronomist; Adjunct Professor of Agronomy, Pennsylvania State University. B.S., 1957, Iowa State University; M.S., 1959, Rutgers University; Ph.D., 1963, Purdue University.
Research Areas: Development and application of laboratory methods of evaluating forage quality. Influence of secondary plant metabolites on forage quality.

ROBERT A. BYERS -- Research Entomologist; Adjunct Assistant Professor of Entomology, Pennsylvania State University. B.S., 1960, Pennsylvania State University; M.S., 1961, Ohio State University; Ph.D., 1971, Purdue University.
Research Areas: Biology, ecology, and control of major legume and grass insect pests. Detection of sources of plant resistance to forage insects. Cooperative research with agronomists and plant pathologists in the selection of disease and insect resistant plants adapted to the Northeast.

GUY W. FISSEL -- Chemist; Adjunct Instructor in Agronomy, Pennsylvania State University. B.S., 1952; M.S., 1955, Pennsylvania State University.
Research Areas: Forage plant analysis of soluble and structural constituents.

GERALD A. JUNG -- Research Agronomist; Adjunct Professor of Agronomy, Pennsylvania State University. B.S., 1952; M.S., 1954; Ph.D., 1958, University of Wisconsin.
Research Areas: Interrelationships among climatic, edaphic, and genetic factors as they affect plant growth and animal performance. Physiology and biochemistry of cold and heat tolerance.

WILLIAM A. KENDALL -- Research Plant Physiologist; Adjunct Professor of Crop Physiology, Pennsylvania State University. B.S., 1949, University of Maine; M.S., 1951; Ph.D., 1954, Ohio State University.
Research Areas: Growth,development and nutritive evaluation of forage legumes. Self and interspecific compatibility of species of Trifolium.

WILLIAM G. LYNCH -- Biological Laboratory Technician; B.S., 1962, Purdue University.

N. DAWN NEIDIGH (Mrs.) -- Clerk Typist (half time).

During the past year we have been reviewing the purpose and mission of the Laboratory. The purpose of the Laboratory is to investigate fundamental problems related to the development and utilization of improved grasses and legumes in the northeastern region. We are developing a mission oriented research program on improving the quality and quantity of grasses and legumes through investigations of the biological, chemical and environmental factors involved in forage and grassland production and use. Our current research is emphasizing three primary goals:

1. Identify and subsequently alter plant metabolic constituents that limit animal feeding value of forages.

2. Investigate the climatic and edaphic factors of the Northeast in order to optimize utilization of the soil and water resources for grassland production.

3. Define the resource value of grasslands and investigate their potential for multiple uses in the northeastern region.

We solicit the counsel and advice of our colleagues in the Northeast in helping us attain these goals.

Robert F. Barnes

Robert F. Barnes
Director, U.S. Regional
Pasture Research Laboratory

Roster of Research Workers in the
Northeastern United States

Name	Field of Research	Department
University of Connecticut Storrs 06268		
Allinson, D. W.*	Forage Management	Plant Science
Cowan, W. A.	Animal Nutrition	Animal Industries
Fellows, I. F.	Agricultural Economics	Agricultural Economics
Peters, R. A.	Weed Investigations	Plant Science
Prince, R. P.	Agricultural Engineering	Agricultural Engineering
Pudelkiewicz, W. J.	Animal Nutrition	Nutritional Science
Washko, W. W.	Forage Management	Plant Science
Wengel, R. W.	Soil Physics	Plant Science
University of Delaware Newark 19711		
Connell, W. A.	Insect and Mite Control	Entomology and Applied Ecology
Crittenden, H. W.	Legume Diseases	Plant Science
Fowler, R. E.	Beef Cattle Nutrition	Animal Science and Agricultural Biochemistry
Haenlein, G. F. W.	Nutritive Evaluation	do.
Jones, E. R.	Forage Management	Dept. of Agriculture Delaware State College Dover, Delaware 19901
Mitchell, W. H.*	Forage Management	Plant Science
Reitnour, C. M.	Horse Physiology	Animal Science and Agricultural Biochemistry
Svec, L. V.	Physiology	Plant Science
University of Maine Orono 04473		
Apgar, W. P.	Forage Utilization	Animal and Veterinary Sci.
Brown, C. S.*	Forage Management	Plant and Soil Sciences
Dickey, H. C.	Forage Preservation	Animal and Veterinary Sci.
Rowe, R. J.	Engineering Harvesting	Agricultural Engineering
Simpson, G. W.	Forage Insects	Entomology

Name	Field of Research	Department
University of Maryland College Park 20742		
Bezdicek, D. F.	Forage Management	Agronomy
Bickley, W. E.	Entomology	Entomology
Burt, G. W.	Weed Control	Agronomy
Clark, N. A.*	Forage Management	Agronomy
Decker, A. M.	Forage Management	Agronomy
Harris, W. L.	Agricultural Engineering	Agricultural Engineering
Hoffmann, L.	Forage Management	Agronomy
Leffel, E. C.	Animal Science	Animal Science
Morgan, O. D., Jr.	Plant Pathology	Botany
Parochetti, J. V.	Weed Control	Agronomy
Schillinger, J. A.	Plant Breeding	Agronomy
Steinhauer, A. L.	Entomology	Entomology
Vandersall, J. H.	Dairy Science	Dairy Science
University of Massachusetts Amherst 01002		
Colby, W. G.	Forage Management	Plant and Soil Sciences
Drake, Mack	Forage Management	Plant and Soil Sciences
Fenner, Heinrich*	Animal Nutrition	Veterinary and Animal Sci.
Jensen, G. L.	Entomology	Entomology
Whitney, L. E.	Agricultural Engineering	Agricultural Engineering
University of New Hampshire Durham 03824		
Byers, G. L.*	Agricultural Engineering	Institute of Natural and Environmental Resources
Colovos, N. F.	Animal Nutrition	Animal Sciences
Dunn, G. M.	Genetics	Plant Science
Holter, J. B.	Animal Nutrition	Animal Sciences
Mitchell, J. R.	Forage Management	Plant Science
O'Conner, J. T.	Animal Science	Animal Sciences
Peirce, L. C.	Genetics and Horticulture Crops	Plant Science
Routley, D. G.	Plant Chemistry	Plant Science

Name	Field of Research	Department
Rutgers University, The State University of New Jersey New Brunswick 08903		
Alderfer, R. B.	Soil-Plant-Water Relations	Soils and Crops
Battle, W. R.*	Forage Breeding	Soils and Crops
Duell, R. W.	Highway Vegetation	Soils and Crops
Evans, J. L.	Nutritional Value	Animal Science
Flannery, R. L.	Soil Fertility	Soils and Crops
Halisky, P. M.	Plant Pathology	Plant Biology
Ilnicki, R. D.	Weed Control	Soils and Crops
Mears, D. R.	Agricultural Engineering	Engineering
Race, S. R., Jr.	Forage Insects	Entomology and Economic Zoology
Ramage, C. H.	Production Utilization	Animal Science
Singley, M. E.	Engineering, Utilization	Engineering
Sprague, M. A.	Management, Preservation	Soils and Crops
Vander Noot, G. W.	Forage Utilization	Animal Science
Cornell University (New York) Ithaca 14850		
Anderson, R. E.	Genetics and Breeding	Plant Breeding and Biometry
Campbell, J. K.	Agricultural Engineering	Agricultural Engineering
Duke, W. B.	Weed Control	Agronomy
Gyrisco, G. G.	Entomology	Entomology
Linscott, D. L.	Weed Control	Agronomy
Lowe, C. C.*	Genetics and Breeding	Plant Breeding and Biometry
Lucey, R. F.	Forage Management	Agronomy
MacDonald, H. A.	Forage Management	Agronomy
Millier, W. F.	Agricultural Engineering	Agricultural Engineering
Murphy, R. P.	Genetics and Breeding	Plant Breeding and Biometry
Pardee, W. D.	Forage Management	do.
Reid, J. T.	Animal Nutrition	Animal Science
Schaaf, H. M.	Genetics and Breeding	Plant Breeding and Biometry
Schultz, O. E.	Plant Pathology	Plant Pathology
Seaney, R. R.	Forage Management	Agronomy
Van Soest, P. J.	Animal Nutrition	Animal Science
Wright, M. J.	Forage Management	Agronomy
Zwerman, P. J.	Soil Conservation	Agronomy

Name	Field of Research	Department
New York State Agricultural Experiment Station Geneva 14456		
Braverman, S. W.	Plant Pathology	Seed Investigations
Dolan, D. D.	Plant Introduction	Seed Investigations and PSR, ARS, USDA
Nittler, L. W.	Seed Research	Seed Investigations
The Pennsylvania State University University Park 16802		
Barr, W. L.	Farm Management	Agricultural Economics and Rural Sociology
Baumgardt, B. R.	Animal Nutrition	Animal Science
Baylor, J. E.	Pasture and Forage Crops (Extension)	Agronomy Extension
Bloom, J. R.	Nematode Control	Plant Pathology
Bratzler, J. W.	Animal Nutrition	Animal Science (Retired)
Cleveland, R. W.*	Genetics and Breeding	Agronomy
Cowan, R. L.	Animal Nutrition	Animal Science
Downs, W. G.	Forage Management	Agronomy (P.O. Rector)
Hershberger, T. V.	Animal Nutrition	Animal Science
Hower, A. A., Jr.	Forage Insects	Entomology
Johnson, M. W.	Corn Breeding	Agronomy
Kardos, L. T.	Soil Physics	Agronomy
Kesler, E. M.	Dairy Science	Dairy Science
Kjelgaard, W. L.	Agricultural Engineering	Agricultural Engineering
Kradel, D. C.	Veterinary Medicine	Veterinary Science
Long, T. A.	Animal Nutrition	Animal Science
Lukezic, F. L.	Forage Pathology	Plant Pathology
Marriott, L. F.	Soil Fertility	Agronomy
McKee, G. W.	Ecology, Physiology	Agronomy
Merritt, T. L.	Animal Science	Animal Science
Partenheimer, E. J.	Agricultural Economics	Agricultural Economics and Rural Sociology
Risius, M. L.	Genetics and Breeding	Agronomy
Shenk, J. S.	Forage Grass Breeding	Agronomy
Starling, J. L.	Genetics and Breeding	Agronomy
Thomas, W. I.	Representing NE Directors	Agricultural Experiment Station
Washko, J. B.	Forage Management	Agronomy
Wilson, L. L.	Animal Science	Animal Science
Yendol, W. G.	Non-Pesticide Insect Control	Entomology

Name	Field of Research	Department
University of Rhode Island Kingston 02881		
Henderson, B. W., Jr.*	Animal Nutrition	Animal Science
Howard, F. L.	Pathology, Entomology	Plant Pathology-Entomology
Wakefield, R. C.	Forage Management	Plant and Soil Science
University of Vermont Burlington 05401		
Bartlett, R. J.	Soil Science	Plant and Soil Science
Benoit, G. R.	Soil Physics	do.
Bornstein, J.	Agricultural Engineering	Agricultural Engineering
Flanagan, T. R.	Weed Control	Plant and Soil Science
MacCollom, G. B.	Entomology	Entomology
McIntosh, J. L.	Soil Science	Plant and Soil Science
Parker, B. L.	Entomology	Entomology
Schneider, E. C.	Agricultural Engineering	Agricultural Engineering
Smith, A. M.	Animal Nutrition	Animal Sciences
Sproston, T.	Plant Pathology	Botany
Varney, K. E.	Forage Management	Plant and Soil Science
Welch, J. G.	Nutritional Value	Animal Sciences
Wiggans, S. C.	Plant Pathology	Plant and Soil Science
Wood, G. M.*	Forage and Turf Management	Plant and Soil Science
West Virginia University Morgantown 26506		
Anderson, G. C.	Animal Nutrition	Animal and Veterinary Sciences
Baker, B. S.	Forage Management	Allegheny Highlands Project, Elkins, West Virginia
Balasko, J. A.	Forage Physiology	Plant Sciences
Bennett, O. L.	Forage Management	Plant Sciences and SWC, ARS, USDA
Butler, Linda	Entomology	Plant Sciences
Diener, R. G.	Agricultural Engineering	Resource Management
Dorsey, C. K.	Entomology	Plant Sciences
Elliott, E. S.	Root Diseases	Plant Sciences
Horvath, D. J.	Animal Nutrition	Animal and Veterinary Sciences
Keefer, R. F.	Soil Fertility	Plant Sciences
Maxwell, R. H.	Agricultural Education	Allegheny Highlands Project, Elkins, West Virginia
Pohlman, G. G.	Soil Fertility	Plant Sciences

Name	Field of Research	Department
West Virginia University Morgantown 26506 (Continued)		
Reid, R. L.*	Animal Nutrition	Animal and Veterinary Sciences
Thomas, R. O.	Dairy Nutrition	do.
Toben, G. E.	Agricultural Economics	Resource Management
Ulrich, Valentin	Plant Breeding	Plant Sciences
Veatch, Collins	Weed Control	Plant Sciences

		Branch
U.S. Department of Agriculture Agricultural Research Service Beltsville, Maryland 20705		
Barrows, H. L.	Branch Chief	Northeast Branch, SWC
Carlson, G. E.	Plant Physiology	Forage and Range Research Branch, PSR
Carter, M. C.	Assistant Branch Chief	Northeast Branch, SWC
Chatterton, N. J.	Biochemistry	Forage and Range Research Branch, PSR
Dahms, R. G.	Branch Chief	Grain and Forage Insects Res. Branch, ENT
Devine, T. E.	Alfalfa Breeding and Genetics	Forage and Range Research Branch, PSR
Garrison, C. S.	Seed Production	do.
Hanson, A. A.	Branch Chief	do.
Hanson, C. H.	Alfalfa Breeding and Genetics	do.
Hart, R. H.	Pasture Production and Management	do.
Juska, F. V.	Grass and Turf Management	do.
Kreitlow, K. W.	Assistant Branch Chief	do.
Leffel, R. C.	Clover Investigations	do.
Luginbill, P., Jr.	Assistant Branch Chief	Grain and Forage Insects Res. Branch, ENT
Neal, J. W., Jr.	Forage Insects	do.
Ostazeski, S. A.	Plant Pathology	Forage and Range Research Branch, PSR
Ratcliffe, R. H.	Forage Insects	Grain and Forage Insects Res. Branch, ENT
Schroder, R. F. W.	Forage Insects	do.
Wilton, A. C.	Grass Genetics and Breeding	Forage and Range Research Branch, PSR

Name	Field of Research	Branch
U.S. Regional Pasture Research Lab. U.S. Department of Agriculture Agricultural Research Service University Park, Pennsylvania 16802		
Barnes, R. F.	Forage Evaluation	Forage and Range Research Branch, PSR
Berg, C. C.	Genetics (Grasses)	do.
Byers, R. A.	Forage Insects	Grain and Forage Insects Res. Branch, ENT
Fissel, G. W.	Chemist	Forage and Range Research Branch, PSR
Gross, C. F.	Soil Fertility	Northeast Branch, SWC
Hill, R. R., Jr.	Genetics (Alfalfa)	Forage and Range Research Branch, PSR
Jung, G. A.	Forage Management	Northeast Branch, SWC
Kendall, W. A.	Plant Physiology	Forage and Range Research Branch, PSR
Leath, K. T.	Pathology (Legumes)	do.
Zeiders, K. E.	Plant Pathology	do.

* Collaborator to the U.S. Regional Pasture Research Laboratory.

RESEARCH IN THE NORTHEASTERN REGION

Section I

Plant Introduction, Genetics, Breeding, Strain Evaluation

Title: REPORT OF REGIONAL PLANT INTRODUCTION, GENEVA, AND REGIONAL PROJECT NE-9 - THE INTRODUCTION, TESTING, MULTIPLICATION, AND PRESERVATION OF POTENTIALLY VALUABLE PLANTS FOR CROP IMPROVEMENT AND INDUSTRIAL USE

Leaders: D. D. Dolan, Coordinator and O. M. Rogers, Chairman, Regional Technical Committee; S. W. Braverman and W. R. Sherring

Cooperators: Fourteen State Agricultural Experiment Stations of the 12 Northeastern States, the New Crops Research Branch, ARS; the Cooperative State Research Service, the Soil Conservation Service, and the Forest Service, USDA

The program of the Regional Plant Introduction Station is directed to growing, evaluating, seed-increasing, and seed-distributing introductions of forage legume and forage grass crops.

During 1970 more than 700 forage legume and grass introductions were grown and described in the biennial catalog of available forage legume and grass introductions. Also, 5000 seed packets were distributed to 200 breeders and cooperators during 1970.

Under date of September 20, 1970, a table was prepared showing traits found in forage legume and grass introductions during the past 17 years of operation of Regional Project NE-9. Copies of this table are available from the Regional Plant Introduction Station, Geneva, for distribution to those interested.

Notes on the promising introductions of 1969 and 1970 were combined with cooperators' evaluations and released as "Promising introductions of 1970" (Supplement II to Annual Report, NE-9, 1970).

The following are some of the promising introductions reported during 1970:

PI 341053 (Medicago sativa) - alfalfa - possible tolerance to leafhopper.
PI 341052 (Medicago sativa) - alfalfa - no or little damage from leafspot, blackstem, or weevil.

An alfalfa (PI 211608 Afgh.) under test since 1955, displays the following desirable traits: winterhardiness, resistance to bacterial wilt, resistance to spotted aphid, resistance to Fusarium wilt, resistance to pea aphid, resistance to leafhopper, tolerance or resistance to downy mildew. Five individual plant selections were taken from 211608 at the P.I. Station, Geneva.

Two diploid alfalfas: PI 259524 and 341052. A Medicago falcata (PI 231731)was used as a parent in breeding 'Weevlchek.'

A red clover (PI 204508) - resistant to pea aphid - Maryland Agricultural Experiment Station.

A red clover (PI 239701) - persistent, resistant to Sclerotinium root rot.

A red clover (PI 204508) resistant to pea aphid.

A red clover (PI 239701) persistent and displaying possible tolerance to Sclerotinia crown rot and root rot.

Four birdsfoot trefoils with good nodulation: PI 187101, 205633, 285278, and 300014.

A birdsfoot trefoil (PI 289776) used in breeding for the following traits: seedling vigor, mature plant vigor, upright habit, fine stems, and small leaflets.

A strong rhizome-spreading red fescue (PI 287548) - New Jersey Agricultural Experiment Station.

A late-maturing, turf-type tall fescue (PI 283299).

A reed canarygrass (PI 235546), the most vigorous, leafy, and disease resistant of several under test.

Two reed canarygrasses (PI 172443 and 316330) both tall and vigorous.

Title: REGIONAL PROJECT NEM-22 -- FACILITATING THE MARKETING OF SEED OF FORAGE AND TURF CROPS THROUGH DEVELOPMENT OF TECHNIQUES FOR EVALUATING VARIETAL PURITY AND IDENTITY

Leader: L. W. Nittler, Chairman, Regional Technical Committee

Cooperators: The New York (Geneva and Ithaca) and Pennsylvania Agricultural Experiment Stations, the Forage and Range Research Branch, Plant Science Research Division, the Seed Quality Investigations, ARS, USDA; and the Seed Branch C&MS, USDA

Different phases of the research to develop improved techniques for identifying varieties were explored at four locations. At Geneva, New York work has concentrated on inducing varieties to express their genetic differences in the seedling stage. Cougar and Fylking Kentucky bluegrass responded to high nitrogen levels by producing three times as many tillers as at low levels. In contrast Newport and Windsor responded little to nitrogen levels. Merion plants treated with 6-azauracil developed an average of 47 tillers per plant. Newport and Windsor developed an average of 6 and 8 tillers per plant.

Experiments with ethrel on red fescue show that 3 or 4 applications of a relatively low concentration result in development of low growing plants with narrow leaves and tall growing plants with wide leaves. Varieties differ in percentage of these two distinctive types.

Oat plants grown with continuous light differed in root development at second and third leaf nodes. No plants of Clintland, Kelsey, Orbit, or Russell developed roots at third leaf nodes compared to 95% of Niagara plants and 100% of Dorval plants.

Barley varieties grown without phosphorus differed in several respects. Over 70% of the area of first leaf blades of several varieties died within 17 days. In contrast very little necrosis developed on leaves of Dickson, Erie, or Vaughn.

At Pennsylvania worked continued on application of instrumental and biochemical techniques to characterize varieties of crop plants. Using paper and thin layer chromatography finger print patterns were run on crude extracts from seeds and seedlings of several varieties and several seed lots each of ryegrass, Kentucky bluegrass, red clover, spring oats, soft red winter wheat, and winter barley. In each of these species, on a single seed or single seedling basis quantitative differences between certain varieties were sizeable but qualitative differences were neither large nor consistent. Several colormetric and spectrometric tests were developed to make it easier to detect such quantitative differences in the above species. In a related study several compounds extracted from the seedcoat of crownvetch were identified. Those that varied enough to be of value in characterizing varieties were umbelliferone, seopoletin,

catechin, anthocyanin, and leucoanthocyanin. Work carried on during the year led to development of field and laboratory keys for identification of varieties of spring oats, winter oats, winter barley, and soft red winter wheat.

At Seed Quality Investigations ARS, USDA work was continued on oxidative enzymes of soybean seed. Three distinct electrophoretic patterns in acrylamide gel zymograms were associated with specific varieties.

At the Seed Branch C&MS, USDA field plantings included 105 cowpea samples and 274 rye samples. Observations were made to characterize 30 rye varieties. Several cowpea varieties were given form descriptions. Twenty-five Kentucky bluegrass varieties were grown in a growth chamber and the leaf epidermis of each was studied microscopically from nail polish imprints.

USEFULNESS OF THE FINDINGS:

In 1970 we continued to add to the knowledge available for identifying varieties and for detecting off types in seed lots. Principles and methods developed with one species have been found, with appropriate modification, to be useful for other species. Methods developed under this project are being used to check varietal purity of seed stocks in the United States, Canada and Europe and thus are helping to improve quality of seed being used. Varietal differences discovered will be available to breeders who want to incorporate distinctive characeristics into varieties.

Title: REGIONAL PROJECT NE-28 -- BREEDING OF IMPROVED VARIETIES OF FORAGE SPECIES ADAPTED TO THE NORTHEAST

Leader: J. A. Schillinger, Chairman, Regional Technical Committee

Contributors: The Connecticut, Maryland, New Hampshire, New York, Pennsylvania and West Virginia Agricultural Experiment Stations, the U.S. Regional Pasture Research Laboratory, and Forage and Range Research Branch, ARS, the Cooperative State Research Service, USDA, and the American Seed Trade Association

Major emphasis is being placed on synthesis procedures and evaluation of synthetic generations of alfalfa, timothy, bromegrass, birdsfoot trefoil, and orchardgrass. Larger variances in agronomic performance and greater inbreeding were associated with small numbers (2-4) of parents in alfalfa synthetics as opposed to larger parental imputs (8-16). Both forage and

seed production measurements are being made on Timothy synthetics in New York. Two of these synthetics have produced consistently higher yields than the Essex and Climax varieties. A 30% decrease was noted for a group of 2-clone synthetics from the Syn 1 → Syn 2 generation whereas no significant change occurred between the Syn 2 → Syn 3 generations.

Evaluation of orchardgrass synthetics indicates that the average performance of Pennlate (Syn 1) exceeds the average of 4 restricted polycrosses involving clones from which Pennlate was produced. Line crosses involving 2 clones were lower in average performance than those derived from 4-clone combinations.

Four multiclone synthetics of bromegrass were evaluated in Syn 1 and Syn 2 generations. Most synthetics yielded 0.5 - 1.0 tons/ha less in Syn 2 than in Syn 1. All synthetics were superior to check varieties in brown leafspot resistance and the Syn 2 was only slightly more susceptible than the Syn 1.

Genetic studies in bromegrass indicate the temperature sensitive albino mutant was inherited tetrasomically as a single recessive gene.

Title: BREEDING AND CYTOGENETIC INVESTIGATIONS ON ALFALFA

Leaders: R. P. Murphy and C. C. Lowe, Cornell

The studies on the multifoliolate character and leafiness in alfalfa were continued. A wide range of variation in leafiness exists in both trifoliolate and multifoliolate populations. Seed of six synthetics varying in leafiness within trifoliolate and within multifoliolate populations is being produced for field plot evaluation.

Part of the study of the cytoplasmic male sterility isolated from a Saranac plant has been completed by Carlos B. Banchero (M.S. Thesis, Cornell Univ. 1970). Meiosis was normal in the male-sterile plant up to the uninucleate stage of the microspores. Thereafter at the stage of the release of the microspous from the tetrods, microsporogenesis became abnormal. The tapetum cells showed discontinuity and breakdown. The pollen grains collapsed and the anthers were shrunken. No binucleate pollen grains were observed in the male-sterile plants. Several male-sterile plants were produced from the original male-sterile plant by crossing it to random plants of Saranac. Eighteen were studied in detail. All were male sterile and some were high in cross fertility when tested by hand pollinations to male-fertile plants. Restoration varied with source of male fertility but none gave complete nonrestoration. With a specific pollinator the several male-sterile clones varied in the amount of restoration. Efforts to produce F_1 seed of the male-sterile clones with Iroquois and with a yellow-flowered selection of Iroquois

at Ithaca in the field have been far from successful. Honeybee activity is very low on the male steriles. However, from this source and from the use of a plant growth chamber with honeybees enough seed has been produced in order that field trials of these hybrids can be made.

Among the new experimental synthetics that have been developed in the past three years, three merit further evaluation. One, a variegated flowered selection from Saranac, will be intensively tested in the field.

The development of inbred lines from Saranac, Iroquois and other sources is being continued.

The selection in the field nurseries for tolerance to the alfalfa weevil has progressed little during the year. The infestations were lighter than in previous years and very sporadic in the nurseries. Preliminary studies on selection for tolerance to the potato leafhopper indicate considerable opportunity for developing cultivars with resistance to this pest. If these observations continue in 1971, considerable effort will be directed toward the development of resistance in new adapted cultivars.

Title: INBREEDING IN ALFALFA

Leader: R. R. Hill, Jr., Pasture Research Laboratory

A description of this study has been given in previous Reports of Forage Research in the Northeast (see p. 16, 1969 report). Continued attempts to produce single cross seeds between inbred lines of alfalfa were made in 1970.

Title: VARIABILITY AMONG FOUR-CLONE ALFALFA SYNTHETICS

Leaders: R. R. Hill, Jr., K. T. Leath and K. E. Zeiders, Pasture Research Laboratory

Two populations of four-clone alfalfa synthetics have been studied. The origin of the two populations and other details are given in the 1969 Report of Forage Research in the Northeast (p. 17). Spring growth, recovery after the first harvest, fall growth and yield were measured for two harvest years. Frost damage caused by a late spring frost (May 9) and number of plants per plot were recorded in 1970. A separate greenhouse experiment was conducted to determine reaction of the synthetics to the following pathogens: Colletotrichum trifolii,

Stemphylium botryosum, Pseudopeziza medicaginis, Leptosphaerulina briosiana, Uromyces striatus, Ascochyta imperfecta, and Corynebacterium insidiosum.

Significant variation within at least one of the populations of synthetics was observed for all characters except fall growth and resistance to S. botryosum and L. briosiana. In most cases, general combining ability was the most important and often the only significant source of variation within populations. The most important single source of variation, however, was that between the means of the two populations of synthetics, which was significant for all characters except resistance to L. briosiana. These results suggest that alfalfa breeders should put most of their efforts into searching for good parent clones and little effort should be devoted to testing numerous combinations which trace to the same source population.

Title: THE BREEDING, GENETICS AND CYTOLOGY OF FORAGE LEGUMES

Leaders: Richard W. Cleveland, John S. Shenk and Marvin L. Risius, Pennsylvania

Breeding of alfalfa for resistance to anthracnose was continued. One cycle of selection for resistance within the varieties Saranac and Iroquois resulted in generations with small differences from unselected varietal sources in percentages of healthy plants. Thus, advances would be slow in a recurrent selection program carried out within these varieties. Populations incorporating germplasm from Team alfalfa may give greater progress in breeding. After one generation of selection in Team, a population was derived with about 75% healthy plants compared to 9 and 14% for Saranac and Iroquois selections, respectively.

Breeding for creeping-rooted alfalfa was continued. Selections were made for early-creeping, upright growth of stems, and plant vigor.

Selections were made from a red clover population inoculated with northern anthracnose and sclerotinia. This population is to be evaluated for major economic characteristics.

Results from forage yield experiments have shown that Saranac and Iroquois alfalfas are superior to most others when grown in central Pennsylvania. In southeastern Pennsylvania several other varieties are superior in yield. Anthracnose may be a major factor affecting location differences in variety yields.

Title: BREEDING OF IMPROVED VARIETIES OF FORAGE SPECIES ADAPTED TO THE NORTHEAST (ORCHARDGRASS AND BIRDSFOOT TREFOIL)

Leaders: Richard W. Cleveland, John S. Shenk and Marvin L. Risius, Pennsylvania

An experiment was continued for the evaluation of orchardgrass strains constituted in several ways from the same parental plants. Data indicate that there was no yield advantage for double crosses or single crosses over stabilized synthetics constituted from Pennmead or Pennlate stocks.

Seed was produced of orchardgrass strains to be used for experiments on strain synthesis techniques. Twelve double cross combinations are in the present production, giving adequate seed for field trials to be established in the coming season. Also, nurseries were planted for seed production of experimental synthetics from regional clones. Four new synthetics were constituted, and a fifth synthetic previously found promising was re-established.

Birdsfoot trefoil experimental varieties were evaluated for forage yield in a 1-year-old field experiment, and a similar experiment was established in 1970 but not harvested. Forage yields of several of the birdsfoot trefoil varieties bred in New York appear to be as high or higher than yields of standard varieties.

Title: BREEDING CROWNVETCH FOR FORAGE AND SLOPE STABILIZATION

Leaders: Marvin L. Risius, Richard W. Cleveland and John S. Shenk, Pennsylvania

Pollen germination and subsequent pollen tube growth were observed in pistils of Coronilla varia after self- and cross-pollinations. Pollen germination and pollen tube penetration of the style occurred within the first 12 hr. The average number of germinated pollen grains on a stigma increased up to 48 hr after pollination. The number of germinated pollen grains on the stigma after cross pollinations was about double that after self pollinations. Estimates of stylar and ovary incompatibility were about the same for both crossing and selfing.

Data from small plot trials for the evaluation of crownvetch as a forage crop indicate that the three crownvetch varieties (Penngift, Chemung, and Emerald) have about the same yield potential. In a seeding rate study, the three crownvetch varieties were seeded at 5, 15, and 25 lb of viable seed per acre. Forage yields were the same for the three seeding

rates in the year following establishment as well as in the succeeding year.

Work has been started to evaluate some of the components of forage quality that may affect the feeding value of crownvetch.

Title: THE PERFORMANCE CHARACTERISTICS OF KENTUCKY BLUEGRASS MIXTURES

Leaders: F. V. Juska and A. A. Hanson, ARS, USDA

It has been suggested that two or more Kentucky bluegrass varieties should be blended to reduce the incidence of disease and insect damage and to produce, on the average, a higher quality turf than that obtained from a single variety planted alone. In this study, apomictic lines that produced high yields growing alone appeared to give the best response in mixtures with other types. This suggests that vigorous selections may become the dominant types in mixtures.

An experiment planted at Beltsville in September 1964 was designed, in part, to provide information on the interaction of six Kentucky bluegrass entries, planted alone and in selected two-entry combinations. All plots received 3 lb of nitrogen as ammonium nitrate each year with phosphorus and potassium maintained at optimum levels.

Pennstar, Belturf, and Merion proved to be the most vigorous used in the mixtures, with a trend toward either increased ground cover, or at least no major reduction in stand, in 1968. However, the relative contribution of Belturf declined when grown in association with Pennstar and Merion. This shift was appreciable with Pennstar and comparatively minor with Merion. The Kentucky blend, which consisted of selected lines from Kentucky, and common Kentucky bluegrass were the poorest performers in this group of bluegrasses. The Kentucky blend was more aggressive than common in 1966, and it held much of this advantage over common in 1968.

Title: BREEDING AND GENETICS OF <u>BROMUS INERMIS</u>

Leaders: G. M. Dunn, M. Nasiruddin and G. Y. Tan, New Hampshire

A 1969 bromegrass synthetic test was harvested in 1970. It included 3-, 4-, 5- and 6-clone synthetics (involving the same 6 parents) of N. H. material, in both Syn 1 and Syn 2, plus 2 additional synthetics from the Pasture Lab. Most synthetics yielded about 0.5-1.0 T/ha less in Syn 2 than in Syn 1, although surprisingly the reverse was true for the 5-clone synthetic. Saratoga and Blair were superior to the other checks,

including Carlton, Fox, Manchar, and Sac. All the synthetics were superior to the checks in resistance to brown leafspot, and the Syn 2 generation was only slightly more susceptible than Syn 1.

The temperature-sensitive albino mutant was inherited tetrasomically as a single recessive gene. Cytogenetic studies indicated that the chlorophyll deficiency was probably due to a gene mutation rather than gross chromosomal aberration. The study supports the 2-genomic model proposed for B. inermis, but does not exclude the 3-genomic model.

Preliminary data indicate that stomatal length increases gradually with an increase in ploidy level from 4N through 6N to 8N Bromus inermis. Stomatal density per unit area is inversely related to ploidy level. Apparently these two characteristics will provide a good preliminary screening for ploidy level in this species.

Title: THE BREEDING AND CYTOGENETICS OF PERENNIAL FORAGE GRASSES

Leaders: John S. Shenk, Richard W. Cleveland and Marvin L. Risius, Pennsylvania

Laboratory procedures were established to evaluate quality of forage harvested from individual clones, synthetics and varieties. Procedures used included plant composition analyses of organic and inorganic components, in vitro rumen fermentation evaluation, and small animal (Microtus pennsylvanicus) feeding trials.

Parental clones from an advanced breeding nursery of orchardgrass were evaluated over five harvests from May 1 to June 19. Significant differences among clones over harvests were obtained for morphology, organic constituents, and in vitro dry matter disappearance. Four crossing blocks were established in the field using clones with distinctly different morphological types. Criteria for selection were growth habit and flowering type.

Seed from several areas of production and several generations of Pennlate orchardgrass are being compared. The results of second-year data indicate that all seed lots are similar in performance and do not differ from the yield of plots seeded with Syn 1 seed. This conclusion is in agreement with analysis of first-year harvest results.

Title: FORAGE PRODUCTION BY NONHEADING ORCHARDGRASS

Leader: C. C. Berg, Pasture Research Laboratory

This test was conducted to measure the density of reproductive tillers and forage production from the Syn 2 generation of three nonheading synthetics developed at the Pasture Research Laboratory. Previous tests showed that, in the Syn 1 generation, Syn A produced about the same number of panicles/ft^2 as Pennmead or Pennlate, but Syn B produced fewer and Syn C still fewer heads. Syn C can be nearly equal to the others, but is usually slightly inferior in forage production under a 2- or 3-cut management system. In 1969, the Syn 2 generation of Syn C produced as much forage as the other synthetics, Pennmead and Pennlate, under a 5-cut system.

Three harvests were taken in 1970. Panicle counts shown in the table were taken before the first harvest. These counts on Syn 2 populations are similar to those obtained previously from Syn 1 populations.

Syn C did not produce as much forage at the first harvest as the other orchardgrass entries. However, at later harvests, yields from Syn C are comparable to most of the other entries. This is consistent with data obtained previously with Syn 1 plantings.

Density of panicles and forage yields from Syn 2 generation of nonheading orchardgrass synthetics A, B, and C orchardgrass and tall fescue checks.*

Strain	No. of panicles/ft^2	Dry matter yields (kg/ha) 6-3-70	7-17-70	9-14-70	Total
Kenwell TF		6717 ab	680 c	4389 a	11799 a
Ky 31 TF		6837 a	967 bc	4262 a	12066 a
Pennmead OG	12.0 b	5389 cd	1260 ab	3315 c	9965 c
Pennlate OG	15.0 a	6276 abc	1301 ab	3955 ab	11532 ab
Syn A	13.5 ab	5963 abc	1281 ab	3408 c	10652 bc
B	9.1 c	5903 bc	1207 ab	3568 bc	10685 bc
C	6.0 d	4876 c	1321 a	3475 c	9678 c

* Duncan's Multiple Range Test: means within a column followed by a common letter are not significantly different, P = 0.05.

Title: CHANGES IN ANTHER TISSUES IN MALE-STERILE ORCHARDGRASS (*DACTYLIS GLOMERATA*)

Leader: C. C. Berg, Pasture Research Laboratory

Developmental changes from meiosis to anthesis were observed in male-sterile and male-fertile orchardgrass. Selected male-sterile plants were compared with plants from the variety Potomac. Inflorescences collected at various stages of development were sectioned and stained with iron-hematoxylin and counter stained with orange G. Development appeared to be normal through meiosis. In male-fertile plants the tapetum layer began to disintegrate soon after meiosis was completed and stained heavily. In plants with male sterile anthers the tapetum cells became quite large, thin walled, and stained very lightly. Simultaneously the young pollen disintegrated (or was crushed) into a dense, deeply, stained, irregular mass in the center of the anther locule. However, the expression of the male-sterile trait was variable. One or more locules in an anther may show the male-sterile trait while pollen may be produced in other locules of the same anther.

Section II

Plant Pathology, Entomology, Selection for Disease and Insect Resistance and Control

Title: BREEDING ALFALFA RESISTANT TO ANTHRACNOSE

Leaders: C. H. Hanson, T. E. Devine and S. A. Ostazeski, USDA, ARS, Beltsville, Maryland

Five alfalfa populations, highly resistant to anthracnose were released to alfalfa breeders. The releases were developed by recurrent phenotypic selection and were designated: Beltsville 1-An4, Beltsville 2-An4, Beltsville 3-An4, MSA-CW3An3 and MSB-CW5An3. Anthracnose resistance in the first three was developed by three cycles of selection in Glacier, Saranac and Vernal, respectively. Two cycles of selection were used to develop MSA-CW3An3 and MSB-CW5An3. Selection in the last two populations had been preceded by 16 to 18 cycles of selection for resistance to other disease and insect pests, including bacterial wilt, common leafspot, leafhopper yellowing and rust. These populations represent a wide array of germplasm and contain from 59 to 87% plants highly resistant to anthracnose. Adapted varieties can be developed from each of these populations for specific areas by field selection of adapted plants with top performance. Several million acres are affected by anthracnose in the eastern half of the United States alone. Anthracnose attacks and kills the stem and crown of alfalfa, thins stands, weakens overwintering capacity and reduces yield and life of the stand.

We also distributed seed of two moderately resistant populations, Beltsville 4-An2 and Beltsville 5-An2, which traced chiefly to introductions from Mexico and Peru, respectively.

Title: ANTHRACNOSE OF ALFALFA

Leaders: F. L. Lukezic, Pennsylvania

Field observations and laboratory isolations have shown Colletotrichum destructivum, which also causes alfalfa anthracnose, to be more widespread in Pennsylvania than C. trifolii. Physiological tests have shown it grows faster than C. trifolii.

Basic research on germination and appressoria formation by spores of C. trifolii has shown that aeration is much more critical than supplementary nutrients. This knowledge reduces the importance that plant exudates were once thought to have on influencing spore germination.

Attempts to increase resistance in alfalfa to southern anthracnose by selecting resistant plants from a normally susceptible population and testing their progeny have been unsuccessful. Thus far, no increase in numbers of resistant plants in the offspring over the present in the normal population has occurred.

Title: ALFALFA PATHOLOGY

Leaders: K. T. Leath and K. E. Zeiders, Pasture Research Laboratory

Several grass and legume species were evaluated as possible hosts for Colletotrichum trifolii, C. graminicola and C. destructivum. Meadow fescue and orchardgrass gave susceptible reactions to all three species. Red clover and alfalfa were susceptible to C. trifolii and C. destructivum. The potential of meadow fescue and orchardgrass as alternate hosts in the disease cycle of southern anthracnose on alfalfa will be investigated further.

The biological activity of alfalfa saponins was determined on the vegetative growth of alfalfa pathogens. Both stimulation and inhibition of growth occurred and the effect on growth varied with the organism, the saponin fraction, the alfalfa source variety and the concentration of the saponins.

Title: ALFALFA MANAGEMENT AND THE INCIDENCE AND SEVERITY OF DISEASE

Leader: F. L. Lukezic, Pennsylvania

Pathogenicity studies of a crownvetch and alfalfa isolate of Sclerotinia trifoliorum have shown that isolates of the fungus obtained from crownvetch and alfalfa are not specific for either host.

A technique for preserving isolates of Corynebacterium insidiosum in soil, which caused bacterial wilt, was developed. This is quite important because normally the organism cannot be held in culture for long

periods of time without loss of virulence. It was determined that isolates of the bacterium persisted for 20 months in sterile soil kept at 40 C without loss of virulence.

Title: MYROTHECIUM LEAF SPOT OF BIRDSFOOT TREFOIL

Leaders: S. W. Braverman, D. D. Dolan and W. R. Sherring, New York (Geneva)

A leaf spotting of birdsfoot trefoil (Lotus corniculatus) was prevalent during the 1968 and 1969 growing seasons at the Northeast Regional Plant Introduction Station, Geneva, New York. Random isolations from affected trefoil leaf tissue revealed Myrothecium verrucaria. Lesions are somewhat less than 1 mm in diameter, are grayish-tan and occasionally with a darkened margin. Many times lesions may coalesce and thus embrace a large portion of the leaf's surface. The organism produces the characteristic annulations of greenish-black sporodochia borne on a flat white mycelial mat when cultured on PDA. Conidia of M. verrucaria are lemon-shaped with a truncate base and measure 2-3 x 6-10 μ.

Several cultivars of Lotus corniculatus and two of L. pedunculatus were inoculated in the greenhouse. A conglomerate of a fungus isolated from 'Empire,' 'Fargo,' and 'Viking' was applied under 70 psi on 2-3 inch seedlings, incubated under 100% rh at 68-75 F, and observed for disease incidence 10 days after inoculation. The reaction of 10 cultivars in order of their susceptibility to M. verrucaria is as follows: 'Granger,' 'Dawn,' 'Canna,' 'Viking,' 'Garrett,' 'Empire,' 'Leo' (P.I. 258467), 'Cascade,' 'Mansfield,' and 'Fargo.' Granger was rated highly resistant; Dawn moderately resistant; Canna, Viking and Garrett slightly resistant; Empire, Leo and Cascade slightly susceptible; and Mansfield and Fargo moderately susceptible. Beaver and Columbia were moderately and highly susceptible, respectively.

Forty-one additional Lotus species were inoculated. Lotus major and L. pusillus were moderately susceptible, while L. arabicus and L. maroccanus were highly susceptible. This constitutes the initial report of M. verrucaria on Lotus species.

Title: RED CLOVER PATHOLOGY

Leaders: K. T. Leath and K. E. Zeiders, Pasture Research Laboratory

The effect of frequency and timing of inoculation with Fusarium roseum on the yield and survival of red clover was investigated in a greenhouse test. Plant mortality was increased and top growth yields reduced by Fusarium inoculations. A stimulation of top growth immediately following inoculation, as reported last year, was not observed.

The effect of internal breakdown on the ability of a plant to produce new top growth from carbohydrates stored in the roots was investigated in a dark recovery test. No relationship between the presence of IB and dark regrowth was established. Selections made previously at the Pasture Research Laboratory for field persistence outyielded Pennscott red clover.

Selections made previously at the Pasture Laboratory for proneness to internal breakdown or persistence were transplanted to the field for further evaluation regarding persistence, yield and disease prevalence. One persistence selection was resistant to powdery mildew during last summer.

Title: SCREENING RED CLOVER INTRODUCTIONS FOR RESISTANCE TO STEMPHYLIUM SARCINAEFORME

Leaders: S. W. Braverman, D. D. Dolan and W. R. Sherring, New York (Geneva)

At the Northeast Regional Plant Introduction Station, Geneva, New York, we grew 550 red clover (Trifolium pratense) introductions and 23 standard cultivars in the greenhouse and evaluated them for resistance to target spot (Stemphylium sarcinaeforme). Seedlings were inoculated using a mixture of 2 cultures from highly susceptible red clover accessions, increased on PDA, comminuted in a blender, and subsequently applied under 70 psi on 3-4 inch tall seedlings. Inoculated plants were incubated under 100% rh at 68-75 F for 48 hr, and then removed to a greenhouse bench. We rated plants for amount and prevalence of infection 10 days after inoculation. P.I.s 235845, 235851 and 235858 were rated as highly resistant, 50 rated as moderately resistant, while 64 introductions varied from slightly resistant to slightly susceptible. The remaining plant introductions were moderately to highly susceptible. 'Wisconsin Mildew Resistant,' N1-17-1-64 (FC 39495, 'Common Indiana Medium,' (FC 39379), and 'Medium Red' (Fc 40232) were slightly resistant. The remaining 20 standard cultivars were moderately to highly susceptible to the pathogen.

Title: GRASS PATHOLOGY

Leaders: K. T. Leath and C. C. Berg, Pasture Research Laboratory

The experimental control of powdery mildew of orchardgrass with a soil drench treatment of Benlate fungicide was continued. Plants that were drenched with 16 ml of an 8000 ppm suspension of fungicide in March 1969 were still resistant to mildew in January 1971. Bioassays in January 1971 for fungitoxic activity in the leaves from treated plants gave positive results.

Title: POWDERY MILDEW RESISTANCE IN KENTUCKY BLUEGRASS AND OTHER POAS

Leader: G. M. Wood, Vermont

Ninety-eight strains of Kentucky bluegrass (Poa pratensis), two strains of rough bluegrass (Poa trivialis) and one strain each of big bluegrass (Poa ampla), Canada bluegrass (Poa compressa) and wood bluegrass (Poa nemoralis) were screened for powdery mildew (Erysiphe graminis) resistance in the greenhouse. All grasses were started from seed and inoculated with the powdery mildew organism from a local collection of susceptible Kentucky bluegrass plants. Considerable variation in resistance was evident but only five of the Kentucky bluegrasses remained completely free during a 7-week test period following initial appearance of the disease. Big bluegrass, wood bluegrass and rough bluegrass were also free of powdery mildew symptoms. Canada bluegrass and several Kentucky bluegrass cultivars and selections were highly susceptible.

Title: BIOLOGICAL CONTROL OF ALFALFA PESTS

Leaders: G. L. Jensen and D. E. Miller, Massachusetts

Research over the past few years has been concerned with the biological control (parasites) and chemical control of the alfalfa weevil. The chemical control project has been dropped in favor of an expanded biological control program. Past years have seen the introduction and impact of studies of several species of alfalfa weevil parasites. Two

hymenopterous parasites of alfalfa weevil larvae, Bathyplectes curculionis and Tetrastichus incertus, have been implicated as primary agents responsible for a decline in alfalfa weevil populations in the State. Two adult weevil parasites, Microctonus aethiops, and Microctonus colesi, have also been recovered from several counties within the state, but population levels for these two species have not been calculated. Results of the 1970 weevil parasite survey indicate that B. curculionis has largely displaced T. incertus as the dominant larval parasite.

A rise in population levels of a dipterous alfalfa leafminer, Agromyza sp., was experienced in 1970. Two species of hymenopterous parasites Closterocerus cinctipennis (Ashmead) and Diglyphus pulchripes (Crawford), were found to be attacking Agromyza sp. larvae.

A project has been undertaken to determine the arthropod predators of the alfalfa weevil The technique utilizes a serological procedure to identify the gut contents of suspected larval predators of the weevil. This technique will reveal the food source of suspected predators and will indicate the approximate time required by certain predators to digest a weevil larva. Results of this project as yet have not been analyzed.

Title: BIOLOGICAL CONTROL OF THE ALFALFA WEEVIL IN NEW YORK

Leaders: R. Larry Richardson, Dean E. Nelson and George G. Gyrisco, Cornell

Each week, beginning in April and continuing until mid-August with the help of County Extension Agents, 27 counties were sampled for parasites. The larvae and adult weevils were counted and reared. Two hymenopterous parasites, Bathyplectes curculionis (Thomson) and Tetrastichus incertus (Ratzeburg) parasitized 16.5% of their hosts. Maximum parasitism by T. incertus and B. curculionis occurred later than periods of peak larval activity of the weevil. T. incertus emerged earlier in several areas and B. curculionis persisted in multiple, nondiapausing generations until late fall. The braconid, Microctonus aethiops (Nees) shows excellent promise and has dispersed through 12 counties since its original release in 1968. B. anurus (Thomson) was successfully established on Ketola Field in Ithaca in 1969 and recovered in 1970.

Recoveries this year included 16 new sites represented by 5 species of parasites. Parasites were released by us at 15 new counties previously not recorded as having any releases made there.

Title: PARASITES OF THE ALFALFA WEEVIL IN MARYLAND

Leader: Robert F. W. Schroder, USDA-ARS, Beltsville, Maryland

Based on data from 10 field surveys in the major alfalfa producing areas of the state, the prominent parasite species was still Bathyplectes curculionus. The level of parasitism by this species was lower than for 1969, however, with a high of about 20% parasitism as compared to 60% for 1969. The adult parasite, Microctonus aethiops was recovered for the first time in Maryland from adults collected in November 1969 from Frederick County. Other parasites recovered from Maryland fields were Microctonus colesi and Tetrastichus incertus.

Title: ALFALFA WEEVIL POPULATIONS IN NEW JERSEY

Leader: S. R. Race, Jr., New Jersey

Economic alfalfa weevil populations failed to develop in most New Jersey alfalfa fields during 1970. This was the second successive year that weevil populations were low and can be attributed to the activity of a complex of parasitic wasps. Indications are that these wasps will continue to maintain alfalfa weevil populations at subeconomic levels.

Title: INTEGRATED CONTROL OF THE ALFALFA WEEVIL IN MARYLAND

Leaders: William E. Bickley and J. W. Neal, Jr., Maryland and USDA-ARS, Beltsville, Maryland

Techniques were perfected for maintaining the alfalfa weevil in the laboratory using trans, trans-10,11 epoxyfarnesenic acid methyl ester to regulate weevil diapause. Topically applied hormonomimetic material was used also to recover, more or less at will, Microctonus aethiops Gyll. adults from parasitized weevils. Field collected weevils were exposed to parasites and stored at 10 C. Laboratory reared, parasitized and diapausing weevils, were treated with hormone so that parasites would emerge April 1970. In each of 2 field, 1200 weevils previously exposed to parasites in the laboratory were released. Previous surveys indicated that M. aethiops was not present. In June 1970, 5 parasites were recovered in one field. The rate of parasitism was estimated to be 0.7%.

Title: EVALUATION OF INSECTICIDES FOR ALFALFA WEEVIL CONTROL AT BELTSVILLE, MARYLAND

Leaders: J. W. Neal, Jr. and R. H. Ratcliffe, USDA-ARS, Beltsville, Maryland

The experimental insecticides ER 6624 and IMC 10001 (Bacillus thuringensis) were evaluated as foliar applications for control of alfalfa weevil. Materials were applied to 10 x 20 ft plots when plants showed approximately 50% tip damage. ER 6624 at the recommended rate of 10 lb/acre gave good control of weevil larvae but was considered too phytotoxic for use. IMC 10001 applied at 300 g/acre gave 50% control of larvae, but difficulty was experienced in spraying this material. A high rate of 1000 g/acre clogged spray nozzles and could not be applied. This compound was of interest in field tests since it had given good kill of larvae in the lab (100% mortality of 3rd instar larvae at a dosage of 0.05% in a dipped stem test), but formulation problems prevented adequate field evaluation.

Tests with Furadan as a granular (2 lb/acre) and foliar (1/2 lb/acre-flowable formulation) application were conducted on 50 x 50 ft plots. Under moderate to heavy weevil infestation, the granular application gave good protection for 6 weeks. The foliar application gave adequate protection for 20 days post-treatment.

Title: EFFECTS OF GAMMA RADIATION ON THE REPRODUCTION OF THE ALFALFA WEEVIL, HYPERA POSTICA (GYLLENHAL)

Leaders: A. A. Hower, Jr. and F. R. Ferrer, Pennsylvania

Studies were undertaken to determine the effect of gamma radiation on the reproduction of the alfalfa weevil, Hypera postica (Gyllenhal). Cobalt 60 was the source of gamma radiation. Doses higher than 3,500 rad induced complete sterility in 3- and 4-week-old male weevils over a 3-month period of oviposition. A dose of 4,500 rad was needed to completely sterilize females. Irradiation of the males alone was as effective in reducing fertility as irradiating both females and males.

Doses above 4,500 rad caused almost a complete cessation of egg production. None of the eggs laid by females irradiated with 3,500 rad and similarly mated developed to adults. Mating competitiveness as well as the capability to transfer sperm was not diminished in irradiated males. Survival of males receiving as much as 4,500 rad at 2 to 5 weeks of age was not affected by the doses employed. Females, likewise, were not affected during 90 days post-irradiation.

Different sequences of normal and irradiated males mating with normal females over a two sequence mating demonstrated a sperm precedence mechanism. Females which after copula were confined with nonirradiated males for 14 days, oviposited an average 96.7% fertile eggs during 15 days. When these females were mated a second time with sterile males, fertility dropped to an average 1.8%. When females were first mated with irradiated males, and mated a second time with nonirradiated males, fertility increased from 0.00 to 84.9%. When mating and confinement periods were reduced to 2 days or 2 to 4 hr, the fertility levels induced by sterile and nonirradiated males were similar to that of the 14-day confinement. However, when the confinement time was reduced to 2 to 4 hr for a third mating with either irradiated or nonirradiated males, fertility levels were influenced less.

Irradiated and nonirradiated males confined in different ratios with females demonstrated a similar mating aggressiveness. Doses of 25,730 to 44,900 were required to induce 50% mortality 7 days after irradiating field-collected weevils.

Title: INFLUENCE OF BORON ON DEVELOPMENT OF THE ALFALFA WEEVIL

Leaders: R. H. Ratcliffe, T. E. Devine and J. A. Schillinger, Maryland and USDA-ARS, Beltsville, Maryland

Trials were established on small field plots at Beltsville and Clarksville, Maryland after reports of lab and greenhouse studies at Purdue indicated a detrimental effect of high boron levels on development and reproduction of the alfalfa weevil. These studies investigated the possibility of applying higher than normal levels of boron to alfalfa as an aid in controlling the weevil. Sodium borate was applied to plots in both locations in the fall of 1969 at rates ranging from 2 to 14 lb boron/acre. Plots at Beltsville were caged in order to force adults to feed on the treated plants, and were infested in the spring of 1970 with lab-reared adults. Plots at Clarksville were uncaged and were naturally infested by adults moving into fields in the fall or spring. Foliage samples were taken from the plots periodically during the spring and were examined for all stages of the weevil. The influence on adults was measured by the number of eggs laid and viability of eggs from samples incubated in the lab. The number, size (average wt) and appearance of larvae and pupae were recorded to determine any adverse effect on development, such as might occur with hormone imbalance.

No influence of boron was noted on survival or development of either immature or adult weevils. There was no reduction in fecundity or viability of eggs laid by adults initially infesting plots or their progeny reared from larvae maintained on treated plants. Some phytotoxicity occurred at the 12 and 14 lb rates, and it would appear that boron levels possibly high enough to influence weevil development would be detrimental to plant growth.

Title: ALFALFA SNOUT BEETLE INVESTIGATIONS

Leaders: Alan C. York and George G. Gyrisco, Cornell

Two new infestations of alfalfa snout beetle were found far removed from the main body of infestation in northern New York. In Jefferson County, an infestation encompassing 14 farms was found in Rutland Township. While the actual area of infestation only covers about 350 acres in total, it poses a very serious threat to the large dairy and alfalfa areas of adjacent Lewis County. The Rutland infestation is about 7 miles east of any known previous infestation. A new county, Wayne was found to be infested in 1970 over an area of about 16 square miles where 21 individual farms had infestations of alfalfa snout beetle on over 300 acres of alfalfa. This new infestation is about 20 miles west of any previously known infestation. Incidentally, the alfalfa snout beetle cannot fly.

In a series of laboratory screening tests, Furadan at 4 oz/acre, and Imidan and Supracide at 8 oz/acre used in baits gave 100% kills within 48 hr.

Title: EFFECT OF SITONA HISPIDULA ON ALFALFA AND ALFALFA-ORCHARDGRASS MIXTURES

Leaders: C. F. Gross, R. A. Byers and R. R. Hill, Jr., Pasture Research Laboratory

Alfalfa and alfalfa-orchardgrass plots, treated with carbofuran on May 13 and with heptachlor on June 12, 1970 to control Sitona hispidula, yielded significantly more forage (0.2 and 0.3 metric tons/ha more) in the third harvest, but not in the first and second harvests. Zero and 0.5 larvae per soil core (15 cm diam X 13 cm deep), were found in insecticide treated plots, vs. 5.8 and 10.8 larvae per core in untreated alfalfa and alfalfa-orchardgrass plots, respectively. Alfalfa-orchardgrass plots had 86.2 and 90.5% alfalfa when treated with insecticides, but only 68.2 and 72.5% alfalfa when not treated for the first and second harvests.

Title: CLOVER ROOT BORER ATTRACTION STUDIES

Leaders: R. A. Byers and K. T. Leath, Pasture Research Laboratory

Clover root borer adults, Hylastinus obscurus, selected diseased red clover crown pieces instead of healthy crown pieces over 80% of the time in a walking bioassay. Root borers placed on healthy crown pieces in a petri dish left these pieces and bored into diseased pieces in the same dish. However, when root borers were placed on diseased crown pieces, they bored into the pieces and did not leave during the 72-hr test.

Title: SURVEY OF NORTHERN CORN ROOTWORM AND OTHER CORN INSECTS IN NEW YORK

Leaders: F. A. Koons and George G. Gyrisco, Cornell

During 1970, five fields in each of 11 counties were surveyed for northern corn rootworm and corn borer using the methods described in the 1969 Annual Report of Forage Research in the Northeastern United States.

Of the counties surveyed, four counties: Jefferson, Monroe, Orleans and Oswego, had no detectable population of adults. Only Broome and Tompkins Counties had more than one adult for every two plants. In no county was there visible rootworm damage or tipped corn. European corn borer damage was very heavy and often infested 100% of the plants. Broken stalks and ears were visible in many fields. No-till corn had the highest incidence of corn borer and may pose some insect problems.

Title: INSECTS (NORTHERN CORN ROOTWORM)

Leader: S. R. Race, Jr., New Jersey

Two experiments were set out during 1970 to determine the influence of several insecticides applied into the furrow at planting time for control of northern corn rootworm attacking field corn. Because rootworm populations were low, results were inconclusive. The effort to find suitable insecticides for rootworm control under New Jersey conditions will continue during 1971.

Section III

Engineering, Production, Management, Weed Control

Title: REGIONAL PROJECT NE-70 - ENGINEERING SYSTEMS FOR FORAGE CROP PRODUCTION AND USE

Leaders: R. J. Rowe (Me.), Chairman, Research Committee; W. L. Kjelgaard (Pa.); D. R. Mears (N.J.) and L. F. Whitney (Mass.)

Contributors: The Maine, Massachusetts, New Jersey and Pennsylvania Agricultural Experiment Stations

A review of fluidization drying and its potential application to forage drying was conducted at Maine. Examples were noted of the use of mechanical agitation of a fibrous interlocking material during drying in order to induce a condition similar to a dense phase fluidized bed.

A review of literature established approximate minimum entrainment velocities for alfalfa. In order to further define entrainment velocities and approximate the incipient fluidization velocity a series of experiments were conducted. Samples of chopped alfalfa were placed in a vertical tube and subjected to various air flows. The incipient fluidization velocity for the samples tested appeared to be about 250 ft per minute. The dry sample was entirely removed by the air stream at 600 ft per minute. It was decided to use bed velocities ranging from 200 to 600 ft per minute in experimental work.

A test facility consisting of a drying chamber with 6 vertical stirring augers was designed and built. Air is supplied to the bed through a perforated floor while forage is to be introduced through an air lock at one end of the chamber and removed from the opposite end in similar fashion.

Consideration was given to the simulation modeling of this process through the use of a residence time function approach.

At Massachusetts the isothermal and nonisothermal diffusion models were compared and it was found that the contribution by thermal diffusion in the overall mass transfer was very little and could be ignored. The nonlinear coupled heat and moisture diffusion equation was then solved numerically in cylindrical coordinates. Experimental drying data were collected for rough rice and potato slices in temperature and relative humidity range of 120-180 F and 20-70%, respectively. Satisfactory

agreement between the experimental and theoretical results for drying of rough rice was found. This work has application in the processing of alfalfa pellets.

Evaluation of the integrated livestock system in New Jerse began with Holsteins in the round barn replacing the former Jersey herd. Various free stall surfaces were tested and cows preferred earth stalls to concrete or asphalt. Improvements have been made in the silage feeding and in the manure handling systems. Also air conditioning has been installed for summer cooling. A linear programming model was developed which determines the least cost cropping and feed purchase programs to maintain a given milk production level. Available resources of land and storage facilities are considered as well as the nutritional requirements of the animals throughout the year.

At Pennsylvania mechanical elements and flow diagrams of various alternatives in forage handling and transport have been prepared. Energy requirement inputs for each factor of forage handling and transport will constitute matrix equations for system analysis and evaluation. The object being to minimize mechanical energy inputs and maximize the feed energy of forage.

USEFULNESS OF FINDINGS:

It is expected that the work outlined will contribute to the development of rapid, continuous flow forage dryers and to the simulation modeling of forage systems which include drying.

Systems engineering methods and linear programming will provide optimal arrangements of forage handling and transport equipment. These arrangements can then be evaluated for research implications and adaptability to practical application. The development of an integrated dairy housing system which minimizes labor equirements offers an attractive solution to dairy housing problems.

Title: ENGINEERING SYSTEMS FOR FORAGE CROP PRODUCTION AND USE

Leaders: D. R. Mears, G. H. Nieswand and M. E. Singley, New Jersey

Evaluation of Integrated Livestock Systems. In July 1970 the Jersey herd in the experimental circular dairy barn was replaced by Holsteins. At the time of the herd change half the free stalls were hard surfaced with several test treatments. Initially the cows preferred the earth stalls to any of the other treatments. Concrete covered with indoor/outdoor carpeting and rubber mats were preferred to either bare concrete or bare macadam. Heating cable under bare concrete will be evaluated this winter.

Modifications were made on the liquid manure handling system to facilitate its operation. The circular trench can be flushed, either half alone or both sides at once. Flushing of the trench, agitation of the storage pit, or unloading of the pit can all be accomplished by manipulating valves. Evaluation of the self-feeder silo is continuing. An air conditioning system for summer cooling has been installed.

Systems Analysis Applied to Forage. A comprehensive study was conducted to determine the best management system for the maintenance of the Rutgers dairy herd. A linear programming model was developed which determines the least cost cropping and feed purchase programs to maintain a given milk production level. Available resources of land and storage facilities are considered as well as the nutritional requirements of the animals throughout the year.

Title: ENGINEERING SYSTEMS FOR FORAGE CROP PRODUCTION AND USE

Leader: L. F. Whitney, Massachusetts

This study is designed to consider forage as a by-product of the protein extract which represents the main product of value. With the exception of single cell protein synthesis such as by algae and yeast, forages produce more protein per acre than any other crop known to man. Wet fractionation is one possible technique for separation. The forage crop will undergo mechanical dewatering with fluidized drying of the pulp. Work has proceeded on mathematical modeling of the drying phenomena to couple the simultaneous heat and moisture transfer during the drying of biological materials. Isothermical and nonisothermical diffusion models were compared and it was found that the contribution by thermal diffusion in the overall mass transfer was very little and could be ignored. The nonlinear coupled heat and moisture diffusion equation was solved numerically on a digital computer in cylindrical coordinates. Experimental drying data collected from rough rice and potato slices dried at 120-180 F and 20-70% relative humidity served as a comparison. Satisfactory agreement between theoretical and experimental results for the drying process was obtained.

Title: WIDTH INFLUENCE IN DRYING FORAGE WINDROWS

Leader: W. L. Kjelgaard, Pennsylvania

Hay conditioners and combinations of hay mowing and conditioning machines such as the "PTO" or self-propelled windrower have windrow making

attachments. These attachments consist of two deflection panels. The degree of convergence of the panels is adjustable and serves as the feature controlling windrow width.

Gathering and consolidating forage crops into a windrow simultaneously with mowing or conditioning reduces the exposed drying surface and delays the rate of drying.

The approach was for eventual harvest as "haylage" where the purpose of windrowing was to delay drying in order to maintain average moisture contents within the correct range for high quality silage.

Mowing and windrow formation occurred about 4 PM on a given day with follow-up moisture sampling during the succeeding day.

Windrow width was significantly important in drying. Generally there were two different drying rate groupings based on windrow width: group 1 included windrow width ratios ranging from 0.25 to 0.36, and group 2 ratios of 0.46 to 0.66 (see table).

Ratio windrow width to mower width	Average moisture content after one day's drying (all 1st cutting)		
	Alfalfa	Red clover	Orchardgrass
	%	%	%
0.25	69	69	40
.30	67	63	35
.36	64	58	26
.46	59	50	25
.57	53	37	30
.66	49	31	28

When harvesting legume silage during clear weather the windrow width should not exceed about 1/3 the swath width if field exposure exceeds one day. For orchardgrass silage overdrying did occur in less than one day of field drying when the windrow width was 1/4 mower width. Mixtures of legumes and grasses for haylage may therefore overdry during one day of clear weather field exposure even in narrow windrows.

Results show that under given exposure conditions, windrow width manipulation can be an important factor in achieving a particular average moisture content for harvesting.

Title: AN INVESTIGATION OF TEDDING UPON FIELD DRYING OF ALFALFA

Leaders: J. K. Campbell and W. F. Millier, Cornell

A sickle bar mower, mower-conditioner, rotary tedder, reel tedder, and self-propelled windrower were used to cut and/or condition the first, second and third cuttings of an alfalfa-grass mixture.

The investigation revealed: (1) The crop cut with the mower-conditioner and tedded dried significantly faster than that cut with the mower-conditioner and not tedded. (2) The crop cut with the mower conditioner dried faster than unconditioned material which had been tedded.

The effect of the various treatments upon drying rate exhibited the same relative order of effectiveness for the three cuttings.

Moisture (w.b.) at 52 3/4 hr, first cutting*	Treatment
21.6	Cut by the mower-conditioner and tedded with the rotary tedder
25.3	Cut by the mower-conditioner and not tedded
26.3	Cut by the mower-conditioner and tedded with the reel tedder
32.7	Cut by a mower and tedded with the reel-type tedder
33.3	Cut by a mower and tedded with a rotary-type tedder
33.7	Cut by a mower--no other treatment until windrowed for baling
33.7	Cut and windrowed by a self-propelled windrower with crimping rolls

* No significant difference between values enclosed by a bracket.

Title: PRE-DIE MANIPULATION, DIE DESIGN AND MATERIALS, AND POST-DIE TREATMENT IN HAY WAFERING

Leader: E. C. Schneider, Vermont

A redesigned ram stroke control system was installed. In the degradation of the pesticide, Tedion in wafered vs. baled hay, the residue in baled hay is higher than in wafered hay.

In the feeding trials with sheep it was determined that sheep are unable to use the hay in wafered form as presented and the trials were discontinued.

Forty-five wafer runs were made since the last report. These were all with the Series 10 full-length 60% bronze-filled, Teflon die at several pressures with different after-cone conditions. The results of these runs have not yet been analyzed. Visual observation shows that the wafers made with this die have an exterior coating of bronze rubbed from the die.

We have started a series of runs with a 25% glass-filled Teflon die of the No. 10 series but of one-half design.

Title: EQUIPMENT FOR PERMANENT HILLSIDE PASTURES

Leader: R. G. Diener, West Virginia

A high speed belt fertilizer thrower was developed to throw fertilizer up to 100 ft in one direction. Speeds of up to 10,000 fpm were used on the belt fertilizer spreader. A graphical intersection plane method was described for determining distance thrown with various size fertilizer particles and velocities from a high speed belt fertilizer spreader. The analog computer was used for interpolation of data from the deflection fingers of the spreader.

The conclusions from the studies to date are: (1) The analog computer can be used as an aid in trajectory simulation and deflector design for the high speed belt fertilizer spreader. (2) Increasing the belt speeds did increase the throwing distances of the belt spreader but at a decreasing rate as the velocity increased. (3) The optimum belt angle for the greatest throwing distance was 35 degrees. (4) With presently marketed granular fertilizer the deflector gives a relatively uniform distribution pattern up to 100 ft. (5) The belt thrower can do an effective job of spreading fertilizer on sloping, hilly terrain and can effectively cover a 195 ft swath on hillside pastures. (6) The belt thrower is also adaptable to level areas such as the Midwest. Swaths of 195 ft are possible with two throwers spreading to each side. (7) Agricultural lime in its present form can only be thrown about 1/3 the distance of fertilizer even under favorable wind conditions.

Title: EFFECT OF SEEDING YEAR HARVEST MANAGEMENT ON FORAGE YIELDS AND PERSISTENCE OF ALFALFA

Leaders: R. R. Seaney, R. F. Lucey and L. W. Hatch, Cornell

Experiments were initiated to study the effects of seeding year management on forage yields and persistence of alfalfa. Ten experiments were established from 1967 to 1970. Saranac and Iroquois alfalfa were seeded alone and the herbicides EPTC plus DNBP or 2,4-DB were used to control weeds. Different cutting treatments were applied during the seeding year, and uniform harvests were made in subsequent years to measure effect of seeding year cutting management. Eight seeding year cutting treatments were used in some experiments, six in others. Cutting treatments the establishment year included different dates of first cut, either three or four dates, with subsequent cuts at 6- or 8-week intervals.

Total forage yields from two cuts the seeding year ranged from 3.4 to 11.0 metric tons/ha (metric tons/ha at 15% moisture). Yields from three cuts ranged from 2.9 to 11.9 metric tons/ha. The seeding year yield advantage of Saranac over Iroquois ranged from -0.2 to +1.3 metric tons/ha, with an average of +0.4 metric tons/ha.

In the seeding year, both percentage of total protein and percentage of leaf content of first cut forage decreased with advancing dates of first harvest. In 1968, first cut forage harvested July 5, July 19 and August 3 had 21%, 16% and 15% protein; and 57%, 51% and 46% leaves, respectively.

Seeding year cutting management influenced forage yields in the second harvest year. In general, the less intensive cutting treatments in the seeding year, two or three cuts with late first cut and 8-week intervals between cuts, resulted in higher forage yields the second year. Second year yields of the less intensive cutting treatments ranged from 0.4 to 2.2 metric tons/ha/acre higher than the more intensive harvest schedules, with an average of 0.7 to 1.1 metric tons/ha. However, this yield advantage of the less intensive seeding year cutting treatments decreased in third and fourth harvest years.

Results of these experiments indicate that seeding year stands of Iroquois and Saranac alfalfa have a potential of producing 4.5 to 11 metric tons/ha of forage. Under favorable climatic conditions, early spring seedlings can be harvested 10 to 12 weeks after planting, and second and third harvests can be made at 6- to 7-week intervals. This system of seeding year cutting management will not adversely affect production in subsequent harvest years.

Title: FALL HARVEST MANAGEMENT OF ALFALFA DURING THE SEEDING YEAR

Leaders: R. R. Seaney, R. F. Lucey and L. W. Hatch, Cornell

In New York State, Saranac and Iroquois alfalfa, seeded without a companion crop in late April or early May, can often be harvested during the period July 5 to July 25. Six to 7 weeks after first harvest, regrowth is adequate for a second harvest. The time for second harvest often falls within September, the month we recommend not harvesting alfalfa. However, some farmers are presently harvesting alfalfa seedlings during September because of forage needs, timing of corn silage harvest, and occurrence of good curing weather.

In view of this, a study was initiated to determine the effect of fall harvest of seeding year alfalfa on second year yields. Seeding year stands of Saranac and Iroquois alfalfa planted April 17, 1968 and May 5, 1969 were cut uniformly on July 26, 1968 and July 24, 1969, respectively. Starting approximately 45 days after first cut, second cuts were made on different dates at 10-day intervals, beginning September 10 and ending October 20. In the second harvest year, uniform harvests were made to measure residual effect of fall harvest in the seeding year. Seeding year yields ranged from 7.4 to 9.9 metric tons/ha (at 15% moisture) and second year yields from 14.8 to 16.1 metric tons/ha. Second year yields for the different seeding year cutting treatments are shown in the following table:

	Seeding year harvest schedule		Total seasonal yield* in second harvest year			
			1969		1970	
	1st cut	2nd cut	Iroquois	Saranac	Iroquois	Saranac
A	June 26	Sept. 10	15.2	15.2	15.7	15.9
B	June 26	Sept. 20	15.2	15.2	15.5	16.1
C	June 26	Sept. 30	15.2	15.5	15.5	15.9
D	June 26	Oct. 10	14.8	15.7	15.7	16.1
E	June 26	Oct. 20	15.5 ns	15.2 ns	15.7 ns	15.7 ns

* Metric tons/ha at 15% moisture.

The results of these experiments indicate that date of fall harvest in the seeding year did not influence persistence or yield in the second harvest year. Similar results have been reported for fall cutting of established stands of Vernal and Saranac alfalfas in Michigan (M. B. Tesar. 1970. Response of alfalfa to frequent cutting and variable dates of fall cutting. Agron. Abstr. p. 57-58).

Title: MANAGEMENT EFFECTS ON PRODUCTIVITY, PERSISTENCE AND QUALITY OF ALFALFA

Leaders: J. B. Washko and J. W. Price, Pennsylvania

After 5 yr only 18 of 30 alfalfa varieties produced enough forage for harvest, from 1.41 to 3.13 T/acre of dry matter. Only bacterial wilt resistant varieties survived into 1970. Varieties harvested at early bloom outyielded those taken at late bud by an average of 0.91 T/acre. Potassium was the only plant nutrient that resulted in an alfalfa yield response on 3 experiments located on Washington silt loam soil. Even this element gave no response beyond 240 lb of K_2O/acre. Nitrogen applied after each harvest with P and K at 20 lb/acre was not harmful to yields but 40 lb of N similarly applied decreased yields. When 4 alfalfa varieties were harvested over 4 yr on different schedules, highest yields the last year were obtained on a 40-day schedule, 1.54 T dry matter/acre contrasted with 0.62 and 0.89 T for 30- and 35-day schedules, respectively. Removal of the first spring harvest at pre-bud (May 14) and early bud (May 21) stages reduced yields 71 and 47.3% compared with the 1/10 bloom stage of maturity. Fall harvests made the seeding year during the 2nd and 3rd weeks of September reduced yields an average of 1.5 T compared with earlier and later harvests.

Title: POTASSIUM FERTILIZATION STUDIES OF ALFALFA IN WEST VIRGINIA IN RELATION TO YIELD AND LONGEVITY OF ALFALFA STANDS

Leader: R. F. Keefer, West Virginia

Application of K at least up to 150 and often up to 300 lb K_2O/acre/year was beneficial in increasing yield and persistence of alfalfa in West Virginia. No additional yield advantage was realized by maintaining available soil K above 300 lb K_2O/acre.

Time of K application may influence persistence depending on location. Early K application, i.e., in early spring, or after the first or second cutting, is usually helpful in maintaining a satisfactory proportion of alfalfa in the stands. Splitting the K application may or may not be beneficial.

Usually 35 to 40 lb K/T was removed in the alfalfa hay. Thus, a yield of 4 T of hay/acre removed about 160 lb of actual K or 192 lb of K_2O/acre. Therefore, in order to provide enough K for a satisfactory hay yield, a minimum of 200 lb K_2O /acre whould be applied annually to an alfalfa hay crop. Prudence would indicate that fertilizer should be applied above this level until the soil tests indicate that fertilizer nutrients are in high amounts.

The above information is in the process of being published as a station technical bulletin.

Title: FACTORS THAT INFLUENCE ALFALFA SURVIVAL ON SLOPING FRAGIPAN SOILS OF THE NORTHEAST

Leaders: G. R. Benoit and J. Bornstein, Vermont

Cooperators: U.S. Department of Agriculture, Agricultural Research Service, in cooperation with the Vermont Agricultural Experiment Station and the U.S. Soil Conservation Service

Alfalfa as a drainage improvement indicator went through a third year on six of the 12 interception drainage research plots. Six plots were planted to corn in 1970. Two plots of each treatment, 100 ft, 200 ft spacing and no subdrain remained in alfalfa and two were planted to corn. After 2 yr, alfalfa survival was reported as 57, 53, and 34% based on alfalfa content in the hay crop. After 3 yr, and following a winter with November through March deep snow cover, the survival rates were 76, 76, and 65, respectively.

Corn silage also yielded in relation to drainage intensity, increasing from no subdrains to 100 ft spacing.

Title: INFLUENCE OF PHOSPHORUS AND LIME LEVELS ON THE YIELD AND VIGOR OF VERNAL ALFALFA

Leader: D. W. Allinson, Connecticut (Storrs)

Vernal alfalfa was grown under 49 combinations of lime and phosphorus (P) treatments. The alfalfa was harvested twice per year in the period 1960-66 and again in 1968, and dry matter (DM) yields determined. Initial soil pH at the 0-15 cm depth was 6.1. In the period 1960-66 there were no significant ($P < 0.05$) differences evident, as reflected by DM yields, among lime levels ranging between 2.24-35.84 metric T/ha. Levels of P ranged from 45-363 kg/ha. Significant yield differences were evident from 1962 onwards as a result of P level. However, there was no significant difference between small annual P applications and a single heavy P application made prior to alfalfa establishment. In no year was the lime x P interaction significant. Seedling stand vigor was influenced by P level

though these differences were not significantly reflected by yield data in the following year. In 1968 significant yield differences were evident on the basis of both lime and P levels.

Title: PRODUCTIVITY AND QUALITY OF FERTILIZED PERENNIAL FORAGES

Leader: L. F. Marriott, Pennsylvania

Applications of various rates and combinations of N, P, K, Mg and trace elements on a 1968 seeding of crownvetch produced no significant yield differences. Where the crownvetch was seeded with grasses, the timothy-fescue association averaged 30% crownvetch while the bromegrass and orchardgrass associations averaged approximately 20 and 10% crownvetch, respectively. Applications of 50 and 100 lb N per acre increased yields of the associations to 3 T/acre from 2 T. The increase was primarily in the grass component. A new seeding of crownvetch was made for further fertility studies.

One of the cultivated fields in Indiana County which received Mg treatments in 1966 was resampled in spring 1970. Where the Mg application was 160 lb/acre or more, the soil Mg level in the 0-6" layer was increased by an amount approximately 35% of that applied. For example, 215 lb Mg/acre resulted in an increase of 0.3 meq Mg over the check plot. Much larger applications were required to significantly increase the Mg level in the 6-12" layer, and this increase over the check amounted to approximately 12% of that applied. The data from the 0-6" samples are in close agreement with the data from a 1967 sampling.

Applications of Mg to three fields in Cambria County had no effect on appearance or yield of oats. The study will be continued to determine whether the forage seeding in the oats will be affected by the treatments.

Title: RELATION OF FERTILITY TO CROP ESTABLISHMENT AND SOIL PRODUCTIVITY

Leaders: Jerry L. McIntosh and Kenneth E. Varney, Vermont

Continuous corn may be successfully grown on clay soils of the Champlain Valley. Manure is a valuable soil amendment but rates of application greater than 10 T/acre are of questionable value. Higher rates of manure in a wet season may actually cause decreases in corn yields. Champlain Valley clays have been capable of releasing enough nitrogen to grow 100 bu/acre of corn in all but wet years. Rates of nitrogen between

50 and 100 lb/acre in combination with 10 T/acre of manure appear to be adequate for most years. Manure treatments greatly increase levels of soil potassium and phosphorus. After 5 yr, rates of nitrogen up to 200 lb /acre had not lowered soil pH. At the nitrogen rate of 200 lb/acre, nitrate concentrations in the soil solution at depths of 80 cm greatly exceeded Public Health standards of 10 ppm nitrogen as nitrate. At times during the season concentrations exceeded 300 ppm. Even though these soils contain large quantities of exchangeable potassium, potassium appears to be a limiting element to corn growing on these soils in a dry year. Yields of corn grain of 100 bu/acre and silage of 20 T/acre may be consistently grown on these soils. Higher yields appear to be limited by factors other than soil fertility.

Title: HARVEST MANAGEMENT OF CROWNVETCH-TALL FESCUE MIXTURES

Leader: A. M. Decker, Maryland

Three varieties of crownvetch (Penngift, Emerald and Chemung) and Ky-63 were grown with Ky-31 tall fescue and uniformly harvested to simulate pasture utilization. In a companion experiment Penngift and Chemung were compared at "pasture," "early hay," and "late hay" harvest with cuts being made at a 1.5-, 2.5-, and 3.5-inch stubble. Ky-63 produced less dry matter than the other three varieties which were similar in performance.

In the harvest management study Penngift was superior to Chemung, especially when harvested frequently and at the low stubble height. The crownvetch component was favored by high stubble harvest (2.5 or 3.5 inches) and pasture type harvesting (harvesting prior to bloom). Frequent harvesting at the low stubble height was the most detrimental treatment with regard to total forage production and to the percentage of crownvetch in the mixture.

Title: TESTING AND MANAGEMENT OF BROMEGRASS FOR LONGEVITY OF STAND

Leaders: V. Ulrich and Gary Santini, West Virginia

The management study was undertaken to record the long range performance of bromegrass under hay and grazing management with a stand that was established in the spring of 1960 and harvested each year. During the 1970 growing season a three-cut hay management with 260 lb of N-P-K yielded 7 T of hay at 13% moisture. The fertilizer was applied as

follows: 100 lb N-P-K on April 15; 80 lb N-P-K after the first cut and during the first week in June; 80 lb N-P-K after the second cut (6 weeks after removal of the first cut or during the middle of July). The third harvest was removed during the first several days of September. Several of the replications, including the grazing paddocks, received another 40 lb of N-P-K, for the purpose of observing fall regrowth. The fourth harvest after the first killing frost which occurred in November produced another ton of dry matter (13% moisture) which had a protein nitrogen content of 14.44%.

During the 1969 and 1970 growing seasons an area of approximately .01 acre was fenced and subjected to grazing by sheep for the equivalence of the second and third hay cut. Fifteen sheep were used for this test each grazing time. The animals were left in this paddock until the grass had been grazed down but not to the point that animals had nibbled the plants to the ground. Fifteen animals were easily maintained for 5 days in these paddocks.

Stand recovery after each grazing episode was excellent and the yields of the grazed paddocks were not statistically different from those under hay management. No trend was found that might suggest that a yield decrease might be occurring. The grazed plant material, which had received 80 lb of N-P-K after the first and second cut, was readily accepted and eaten by the ewes.

The stand at the present time, April 19, 1971, is in excellent condition for another year of grazing. This system of high fertility with careful management of a very highly productive and improved species appears to be extremely promising for areas where the slope of the pastures make plowing and stand reseeding difficult.

Title: ESTABLISHMENT, CULTURE AND MANAGEMENT OF FORAGES

Leader: M. A. Sprague, New Jersey

A sodded pyramid designed for microclimate studies in the biosphere was re-fitted with thermocouples at 1, 4 and 8-inch soil levels, rain gauges and soil moisture blocks. Major heat differences appear at the equinox not the solstice. Temperature and moisture profiles in the soil differ greatly on the 4 slopes which must certainly alter both soil chemistry and root growth. Squall-type rainfalls differ as much as 100% on different slopes. Seed of ecotypes of Trifolium repens have been obtained from Denmark, New Zealand, Iran and South Africa for use in testing biological response.

Title: THE CONTROL OF WEEDS FOR PASTURE AND FORAGE PRODUCTION

Leaders: Collins Veatch and G. C. Anderson, West Virginia

Aerial applications of 2,4,5-T and 2,4-D on hill pastures accomplished reasonable control of blackberry and crategus species (thorn apple). Effectiveness varied from 20-100% and was influenced to a marked degree by temperature and moisture conditions. Treatment was without significant effect on maple, oak and hickory. An average control of 65% for blackberry and crategus species is estimated. Retreatment within 3 years is considered necessary to retain benefits of original treatment. Adjustments in stocking rates, fencing, rotation and fertilization are necessary adjuncts in the control of woody plant species on hill pastures.

Combination of Tordon and 2,4,5-T have been highly effective in the control of crategus species. Tordon in a dry form has been effective in the control of hickory, maple and oak on small experimental hill areas.

Title: EVALUATION OF HERBICIDES FOR WEED CONTROL IN ESTABLISHED ALFALFA

Leaders: R. A. Peters and W. M. Dest, Connecticut (Storrs)

Nine herbicides each at two rates were applied to an old alfalfa-orchardgrass stand on April 16, 1970 as the alfalfa was breaking dormancy. The predominant weeds present were white cockle, dandelion, quackgrass and chickweed.

Orchardgrass was killed or greatly inhibited by Paraquat 1/2 or 1 lb AI/acre plus X-77 surfactant, RH 315 at 1-1/2 or 3 lb AI/acre, Bay 94337 at 1/2 and 1 lb AI/acre, diuron at 2 lb AI/acre, simazine at 2 lb AI/acre, G14254 2 lb AI/acre and Terbacil 1/2 and 1 lb AI/acre. Alfalfa was seriously injured by simazine 2 lb AI/acre and Terbacil 1 lb AI/acre. Dandelions were controlled by G14254 at 1 + 2 lb AI/acre, Terbacil at 1/2 and 1b AI/acre and Bay 94337 1 lb AI/acre. All of the chemicals mentioned controlled common chickweed except for simazine at 1 lb AI/acre.

Simazine at the registered rate of 1 lb AI/acre and 2,4-DB amine at 1/2 and 1 lb AI/acre gave poor weed control.

Bay 94337 at 1 lb/acre, G14254 at 2 lb/acre and Terbacil at 1/2 lb AI/acre removed both orchardgrass and weeds without injury to alfalfa.

Title: TANK MIXTURES OF DALAPON-DINOSEB VS. SPLIT APPLICATIONS

Leader: Dean L. Linscott, USDA - Cornell

Tank mixtures of dinoseb-dalapon damaged alfalfa more extensively than did split applications 2,4, or 24 hr apart in the 1969 and 1970 field trials. Leaves of alfalfa were burned more severely by the mixtures. The population of alfalfa was significantly decreased by the tank mixture in 1970 and a similar trend was detected in 1969. These observations on early damage to the plants and a significant reduction in plant numbers have been confirmed by studies in controlled environments.

Differences in alfalfa yield between the treatments have not been demonstrated conclusively. Therefore, it would be premature to suggest an economic advantage for split applications of dinoseb-dalapon over tank mixtures. Nevertheless, the tank mixture does increase early damage to alfalfa and we intend to determine the reason for it. First indications are that the spray droplet contact angle is less for the tank mixtures. Thus, a greater spreading over the leaf surface probably resulted. This premise is being studied further in controlled environmental systems.

Title: HERBICIDES FOR WEED CONTROL IN SEEDLING RED CLOVER AND BIRDSFOOT TREFOIL

Leader: Dean L. Linscott, USDA - Cornell

Red clover and birdsfoot trefoil in all plots including controls established successfully. However, tonnage of clover from plots receiving herbicides was as much as 1500 lb/acre greater based on two cuttings (Table 1). Similarly, birdsfoot trefoil plots treated with herbicides yielded as much as 2250 lb/acre more than controls (Table 2). Red clover was stunted early by the 4 lb/acre EPTC treatment and was further damaged by dinoseb or 2,4-DB applications. However, these effects were not noticeable when yields were taken.

Dinoseb at 1/4 lb/acre or EPTC at 2 lb/acre alone at rates used were unsatisfactory for controlling broadleaf weeds. However, the combination treatment resulted in excellent control of both broadleaf weeds and grasses. EPTC alone controlled annual grasses during the season whereas when dinoseb or 2,4-DB was used, broadleaf weed competition was decreased and the grass population increased significantly. Considering the weed population in this study and the relative cost of chemicals, the most satisfactory treatment

was dinoseb applied at 1/4 or 1/2 lb/acre after the 2 lb/acre EPTC treatment. Similarly 2,4-DB at 3/4 lb/acre following EPTC was highly satisfactory.

The stand of red clover was not significantly affected by chemical treatment. Conversely, 6 weeks after planting, plots receiving EPTC alone or followed by dinoseb had double the numbers of birdsfoot trefoil plants. Birdsfoot trefoil is quite sensitive to competition the first few weeks after planting. Thus, the numbers of birdsfoot trefoil on June 16 were inversely proportional to the numbers of weeds in the plot at that time.

It is significant that adequate weed control was obtained by lower than normal rates of EPTC when followed by lower than normal rates of dinoseb or 2,4-DB. If perennial grasses and sedges are a problem (in these plots they were not) at least 4 lb/acre of EPTC should be used. A reduced rate of dinoseb or 2,4-DB following the higher rate of EPTC could be used successfully for weed control and at the same time not seriously affect legume stand. For the postemergence treatments to be most effective in this system, the weeds escaping EPTC treatments must be sprayed when 3 inches or less in height.

Table 1. Effect of preplanting (incorporated) applications of EPTC and postemergence application of dinoseb or 2,4-DB on population of weeds and red clover and the yield of red clover.*

Treatment, lb/acre				Damage	Stand†			Yield		
preplant inc.		Post-emerg.		red clover June 8	Red clover June 16	Weeds June 16	Grass June 16	Red clover, lb/acre July 23	Sept. 17	Total
EPTC	0	DNBP	0	0 e	61	84 a	9 b	1516 c	3868 abcd	5374 d
do.	2	do.	0	10 cd	73	35 b	1 c	2348 b	3906 abcd	6250 bc
do.	4	do.	0	22 bc	76	23 bcd	0 c	2512 ab	3834 abcd	6348 abc
do.	0	do.	1/4	2 d	56	69 a	14 ab	2404 b	4032 ab	6440 abc
do.	2	do.	1/4	10 cd	82	9 bcd	2 c	2948 a	3576 cd	6526 ab
do.	4	do.	1/4	40 a	74	3 d	0	2558 ab	3924 abc	6482 ab
do.	0	do.	1/2	0 b	62	32 bc	19 a	2924 a	3198 abcd	6844 a
do.	2	do.	1/2	14 cd	80	14 bcd	1 c	2912 a	3634 cd	6546 ab
do.	4	do.	1/2	38 a	76	2 d	0 c	2526 ab	3910 abc	6430 abc
do.	0	2,4-DB	3/4	11 cd	60	4 d	12 b	2592 ab	4064 a	6658 ab
do.	2	do.	3/4	10 cd	80	5 cd	1 c	2606 ab	3628 cd	6230 bc
do.	4	do.	3/4	36 ab	79	2 d	0 c	2268 b	3644 cd	5992 bc
do.	0	do.	1 1/2	2 d	70	9 bcd	13 b	2514 ab	3830 abcd	6344 abc
do.	2	do.	1 1/2	14 cd	90	4 d	0 c	2570 ab	3174 d	6282 bc
do.	4	do.	1 1/2	34 ab	90	1 d	0 c	2538 b	3746 abcd	6504 ab

* Means within columns with no letter or the same letter designation are not significantly different at the 0.05 level according to Duncan's Multiple Range Test.

† Damage rating 0 - 99 in increasing order of intensity. Stand taken from 2 meters of row.

Table 2. Effect of EPTC (preplanting, incorporated) and DNBP (postemergence) on early damage, plant numbers and birdsfoot trefoil and weeds and yield of birdsfoot trefoil.*

Treatment, lb/acre				Damage (June 8)†			Stand (June 16)			Birdsfoot trefoil yield, lb/acre		
PPI		Post E		Bft.	Br.	Gr.	Bft.	Br.	Gr.	July 23	Sept. 17	Total
EPTC	0	DNBP	0	0 f	0 c	0 c	32 d	80 a	7 b	1754 d	2699 b	4454 d
	2		0	4 c	50 bc	99 a	38 cd	49 ab	3 b	1748 d	3126 a	4874 cd
	4		0	6 bc	79 bc	99 a	57 abc	9 ab	0 b	2286 c	3227 a	5510 bc
	0		1/4	2 cd	58 bc	0 c	33 d	42 bc	17 a	2948 ab	2950 ab	5898 ab
	2		1/4	8 bc	80 bc	50 b	48 bcd	27 bcd	6 b	3134 ab	3320 a	6454 a
	4		1/4	12 ab	98 ab	99 a	65 ab	2 d	0 b	2778 bc	3383 a	6160 ab
	0		1/2	2 cd	70 bc	0 c	45 bcd	22 bcd	19 a	3402 a	3305 a	6708 a
	2		1/2	12 ab	90 ab	99 a	61 abc	7 cd	0 b	3274 ab	3555 a	6628 a
	4		1/2	20 a	99 a	99 a	72 a	3 d	0 b	2848 b	3364 a	6212 ab

* Means within columns with no letter or the same letter designation are not significantly different at the 0.05 level of significance according to Duncan's Multiple Range Test. PPI = preplanting incorporated; Bft. = birdsfoot trefoil; Br. = broadleaf weeds; Gr. = grass weeds.

† Damage rating 0 - 99 in increasing order of intensity. Stand taken from 2 meters of row.

Title: ESTABLISHING CROWNVETCH FOR SEED PRODUCTION

Leader: Dean L. Linscott, USDA - Cornell

Study I

Weed control resulting from the application of EPTC or benefin and followed by between-row applications of simazine or bromacil was outstanding during the entire 1970 season. Damage to crownvetch from chemical action was minimal except in those plots receiving 2 lb/acre of bromacil and even these equaled or exceeded control plots in plant numbers in October. The most satisfactory plots from the standpoint of weed control and crownvetch stand were those which received either EPTC or benefin and simazine or the 1 lb/acre rate of bromacil (Table 1). Plants from these plots were considerably more vigorous than control plants and were at least 1.6 times more numerous. Crownvetch stem numbers increased between June and October in most plots. These increases probably were due to development from rhizomes and not from late germinating seeds. By early September, crownvetch had covered the plots with the better weed control and in some cases flowering was initiated.

Early in the season some control of weeds within the seeded row was obtained from between-row applications of simazine or bromacil alone. This effect probably was caused by uptake of the herbicide from lateral roots of weeds growing close to the surface and to limited surface movements of chemical into the seeded row. The condition was temporary and weeds developed in the row late in the season sufficiently to compete with crownvetch. In these cases season-long weed control was maintained between the rows.

This study demonstrated that simazine and bromacil could be placed as close as 4 inches to the seeded row with minimal damaging effect to crownvetch. Careful adjustment of the spray apparatus was necessary to keep herbicide spray out of the seeded row. For commercial practice, we suggest that the simazine or bromacil band be no closer than 6 to 8 inches to the seeded row. Drilling with the slope will be helpful in preventing surface movement of the herbicide into the row.

Studies II and III

Little damage to crownvetch was noted from benefin applications alone or when followed by dinoseb (Table 2). However, early in the season, crownvetch was stunted considerably when dinoseb followed EPTC (Table 3). The stunted plants recovered for the most part. By seasons end, the most satisfactory plots in both Studies II and III were those which received treatments with benefin or EPTC followed by dinoseb postemergence. Dinoseb alone was unsatisfactory for broadleaf weed control. Similarly,

Table 1. Effect of EPTC or benefin applied to the entire plot prior to planting (incorporated) and simazine or bromacil applied at planting between seeded rows of crownvetch on early damage and subsequent stand of crownvetch and weeds.*

Treatment, lb/acre				Weeds								Crownvetch		
				Damage† June 10				Plants‡ June 16				Damage†	Plants‡	
Overall		Between row		In row		Between row		In row		Between row		June 10	June 16	Oct. 19
				Br	Gr	Br	Gr	Br	Gr	Br	Gr		no.	no.
Control				0	0	0	0	32 a	13 a	33 a	9 a	0	26 ef	28 d
		Simazine	1	17	19	94	94	25 ab	10 ab	>1 d	<1	4	33 de	32 d
		do.	2	27	20	95	96	15 cd	8 b	<1 d	<1	6	38 bcd	41 bc
		Bromacil	1	16	7	95	99	26 ab	8 b	<1 d	<1	6	33 d	31 d
		do.	2	12	1	99	99	18 bc	8 b	<1 d	<1	7	25 f	28 d
EPTC	3		0	73	99	79	98	5 de	<1 c	6 c	<1	0	46 a	39 c
do.	3	Simazine	1	98	99	99	99	2 e	<1 c	<1 d	<1	3	43 ab	50 a
do.	3	do.	2	99	99	99	99	2 e	<1 c	<1 d	<1	11	42 abc	49 a
do.	3	Bromacil	1	96	99	99	99	7 de	<1 c	<1 d	<1	11	38 bcd	46 ab
	3	do.	2	93	99	99	99	3 e	<1 c	<1 d	<1	22	33 d	38 c
Benefin	1.5		0	52	99	51	96	13 cd	<1 c	14 b	<1	0	38 bcd	41 bc
do.	1.5	Simazine	1	46	93	97	96	14 cd	>1 c	<1 d	<1	2	42 abc	47 ab
do.	1.5	do.	2	46	99	95	99	13 cd	<1 c	<1 d	<1	10	43 ab	48 a
do.	1.5	Bromacil	1	36	98	93	98	16 cd	<1 c	<1 d	<1	2	35 cd	53 a
do.	1.5	do.	2	79	99	99	99	9 cde	<1 c	1 d	<1	25	32 def	38 c

* Duncan's Multiple Range Test for significance at 0.05 level was used. Entries with no letter or identical letters are not significantly different. Visual rating data were not analyzed statistically.

† Scale 0-99 in increasing order of damage to plants based on visual estimates. Br = broadleaf weeds, Gr = weed grasses.

‡ Plant numbers are based on counts from 2-meter lengths of row (7" x 39"). Rows seeded 28 inches apart.

Table 2. Effect of preplanting (incorporated) applications of benefin followed by postemergence treatments with dinoseb on early damage and subsequent stand of weeds and crownvetch.*

Treatment, lb/acre			Weeds				Crownvetch		
			Damage†		Plants‡		Damage†	Plants‡	
PPI	Post E		June 18		June 17		June 18	June 18	Oct. 19
			Br	Gr	Br	Gr		no.	no.
Control			0	0	29 a	6 c	0	19 d	17 e
Benefin 1	Dinoseb	0	42	98	28 ab	2 d	0	28 bcd	26 bcd
2		0	60	94	19 bc	4 c	0	27 bcd	28 ab
0		1/4	36	0	31 a	15 a	0	26 cd	20 cde
1		1/4	78	92	10 c	<1 d	0	35 abc	34 ab
2		1/4	84	99	12 c	<1 d	4	37 ab	36 a
0		1/2	44	0	27 ab	10 ab	0	27 bcd	19 de
1		1/2	78	92	10 c	1 d	0	46 a	35 ab
2		1/2	86	99	10 c	1 d	6	38 ab	35 ab
Cultivation			54	54	19 bc	5 c	0	18 d	16 e

*, †, and ‡ - See Table 1.

Table 3. Effect of preplanting (incorporated) applications of EPTC followed by postemergence treatments with dinoseb on early damage and subsequent stand of weeds and crownvetch.*

Treatment, lb/acre			Weeds				Crownvetch		
			Damage†		Plants‡		Damage†	Plants‡	
PPI	Post E		June 18		June 17		June 18	June 18	Oct. 19
			Br	Gr	Br	Gr		no.	no.
Control			0	0	59 a	11 b	0	20 c	20 c
EPTC 2	DNBP	0	70	99	35 bc	<1 c	4	31 ab	25 cde
4		0	82	96	23 cd	2 c	4	35 ab	27 bcd
0		1/4	44	0	43 b	19 a	4	21 c	21 ef
2		1/4	90	96	16 de	4 bc	28	32 ab	29 abc
4		1/4	99	99	13 de	1 c	44	36 a	32 a
0		1/2	68	0	36 bc	22 a	8	27 bc	24 def
2		1/2	98	96	10 de	2 c	52	32 ab	26 bcd
4		1/2	96	99	6 e	9 bc	52	36 a	30 ab

*, †, and ‡ - See Table 1.

benefin or EPTC alone were unsatisfactory for late season broadleaf weed control although considerable benefits were realized early. Both pre-emergence chemicals controlled annual grasses satisfactorily for the season.

Title: MIDLAND BERMUDAGRASS FORAGE YIELDS AND WEED CONTROL AS INFLUENCED BY SOD SEEDING, FLAMING, AND NITROGEN FERTILIZATION

Leaders: A. M. Decker and W. L. Harris, Maryland

A uniform sward of Midland bermudagrass, which had been grazed for the past 5 yr, was used to evaluate the effects of stubble flaming, sod seeding, nitrogen rates, and nitrogen sources on weed control, dry matter yields, and nitrogen recovery. The greatest reduction in winter annual weeds was with sod seeding followed by late flaming (April 27). Early flaming (March 3) changed the weed composition but was no better than untreated plots. Spring germinating weeds were actually increased with early flaming. Highest weed-free forage yields were obtained from the sod-seeded treatments with late flaming being next. Flaming increased yields regardless of nitrogen source or rate of application. However, the greatest increase was at the lower nitrogen levels. The percentage of nitrogen recovery was not significantly increased by flaming. It was about 5% higher for urea over NH_4NO_3. This is in contrast to most reports in the literature. Spring growth of the bermudagrass was not stimulated by flaming.

Section IV

Growth, Physiology, Environmental Effects and *Rhizobia* Studies

Title: THE ROLE OF SOLUBLE CARBOHYDRATE RESERVES IN PERENNIAL COOL SEASON GRASSES

Leaders: W. G. Colby and Mack Drake, Massachusetts

In past annual reports, we have summarized our work on soluble carbohydrate reserves in three important perennial forage grass species, orchardgrass, timothy and smooth bromegrass. Following are some general summary observations and conclusions:

1. Carbohydrate reserves play an important and often vital role in the life cycle of the plant as an energy source:

    a. During the period of winter dormancy

    b. To initiate new root and top growth in early spring

    c. To supplement photosynthetic energy during the period of rapid growth and elongation ending with the early head stage

    d. To initiate tiller growth following first harvest. This is the most critical growth stage. If energy reserves are too low to support or initiate new tiller growth, severe injury and often complete loss of stand may result. Injury can be prevented by suitable management practices such as delayed date of harvest or more moderate levels of nitrogen fertilization, but little can be done to alleviate or reduce injury if reserve levels at time of harvest are critically low. This is usually during the period of rapid growth or dry matter increase from the beginning of stem elongation to the early head stage. With the cessation of dry matter increase at early heading, carbohydrate reserve levels build up very quickly.

The rate of growth or dry matter increase depends primarily on temperature, available moisture, and fertility level which in most circumstances is available nitrogen. Species responses may vary as a result of morphological differences. For example, rhizomatous species are less sensitive than nonrhizomatous species because rhizomes are an important energy storage organ. Species or strains with large leaf surface areas are less sensitive than species or strains with lesser leaf surface areas.

Temperature is usually the most important controlling factor. At relatively low mean temperatures growth rates during the period of elongation are moderately low and carbohydrate reserve levels seldom fall to critical levels regardless of nitrogen levels or other growth promoting conditions. At relatively high temperatures growth rates during this period are much higher and, as stated above, carbohydrate reserves may be reduced to critical levels even at moderately low levels of available nitrogen.

The role of temperature should also be mentioned during the one or more periods of aftermath growth. The situation here is substantially different than during the period of pre-maturity growth. With most species (orchardgrass may be an exception), aftermath growth rates are relatively lower. However, mid and late summer temperatures are relatively high with the result that photo or light respiration becomes an increasingly important factor. Carbohydrate reserve levels fall not because of high growth rates but because of low net photosynthetic rates due to high temperatures. This area needs to be explored more fully and without delay.

Title: REESTABLISHMENT OF LEGUMES IN PERMANENT PASTURES

Leader: C. F. Gross, Pasture Research Laboratory

Ladino clover growth in soil did not approach that obtained in a nutrient solution study (see p. 66 of the 1969 Report). Although considerable increase in fertilization levels were made to the soil cultures, i.e., over 400 lb/acre where the legume and grass were grown in association, corresponding increases in clover yields were not procured. In addition, growing the ladino under various soil moisture regimes had little effect on clover production. This may be related to the contrasting root environments that exist between the two growing media, e.g., differences in ionic concentrations and plant tissue and/or bacterial decomposition products, or to some other factor(s).

Factors other than fertilization, soil moisture and light appear to be involved in the decreased growth of ladino clover where the clover is grown together with orchardgrass in soil compared to that obtained where the clover and grass are grown in association employing nutrient solutions. Two such factors that may be implicated in this differential growth response of ladino when grown in soil vs. solution culture concerns the conditions prevailing relative to the root environment and/or plant and bacterial decomposition materials. Therefore, an investigator should exercise much care in extrapolating data from nutrient solution culture experiments.

Title: MANAGEMENT EFFECTS ON MORPHOLOGY AND PHYSIOLOGY OF TIMOTHY AND REED CANARYGRASS

Leaders: J. B. Washko and Paul Mislevy, Pennsylvania

Initial harvests of Climax timothy and Pennlate orchardgrass were removed at three maturity stages; transition (vegetative-stem elongation), boot and anthesis. These were followed by removal of aftermath at five different plant heights. First-year data show that orchardgrass removal at 18 to 22 in. resulted in a 2 T/acre dry matter increase for the season compared with removal at a 4- to 6-in. plant height. Removal of timothy aftermath at 18 to 22 in. produced a 1 T/acre increase in dry matter compared with removal at 4 to 6 in. Nonstructural carbohydrates are presently being determined on plants following each harvest. Under greenhouse conditions removal of the initial harvest of timothy at the vegetative and transitional maturity stages produced more tillers, higher dry matter and higher TDN than first harvest removal at more advanced growth stages.

Title: RESPONSE OF REED CANARYGRASS TO SUB-HERBICIDAL APPLICATIONS OF SIMAZINE

Leader: D. W. Allinson, Connecticut (Storrs)

The herbicide simazine, 2-chloro-4,6-bis (ethylamino)-s-triazine, was applied at four rates, 0, 1/4, 1/2, and 1 lb actual simazine/acre to a reed canarygrass stand. Applications were made (a) as a single application in the spring and (b) in split applications, 50% in the spring and the remainder following the second harvest. Three harvests were taken. Two rates of nitrogen, 200 and 400 lb N/acre, were used.

Increasing applied rates of simazine above 1/4 lb ai/acre decreased dry matter (DM) yields ($P < 0.01$). However, when simazine was applied in split applications, rates up to 1/2 lb ai/acre did not reduce DM yields. Simazine applications increased the crude protein content of reed canarygrass. Split applications of simazine resulted in higher protein contents in third harvests and lower contents in first and second harvests compared to single simazine applications. Simazine responses were still evident when percentage of alcohol insoluble protein was determined. The greatest yields of crude protein were obtained (a) at a 1/2 lb ai simazine/acre level using split applications and (b) 1/4 lb ai simazine/acre using a single application.

Simazine applications reduced the percentage of cell wall constituents (CWC) of the forage. Reduction of CWC was especially noticeable at high

simazine rates applied in single applications. The percentage of acid detergent fiber, but not acid detergent lignin, of the tissues was similarly reduced. The NO_3-N content was considerably greater in those tissues treated with simazine.

Title: ENVIRONMENTAL STUDIES WITH PLANTS

Leaders: A. M. Decker, D. T. Hawes and J. M. Walker, Maryland

Environmental studies with forage crops, field crops, and turf grasses on field plots with soil temperatures set for ambient, 10, 21, and 32 C were in progress during the past year. The effects of soil temperature on top and root growth, crown development, and forage quality were studied on timothy, orchardgrass, and tall fescue. Corn and soybean seedlings were grown on these plots in two soils with two boron levels in order to test in the field the hypothesis that high temperature limits growth by lowering calcium translocation and increasing boron accumulation in plants. Results did not substantiate earlier findings in the laboratory. A lack of adequate soil moisture control appeared to be a major reason. Soil temperature had a marked influence on plant reserves, tiller initiation, leaf growth, and crown development of turf as well as forage grasses. Soil temperatures either directly or indirectly caused changes in soil organic matter, soil aggregation, infiltration rates, and nutrient content.

Title: EFFECTS OF SLOPE INCLINATION AND ORIENTATION ON YIELD AND WATER USE OF FORAGE SPECIES (BLUEGRASS)

Leaders: O. L. Bennett and E. L. Mathias, West Virginia

Bluegrass produced from 2 to 7 times more forage over a 3-year period on a northern exposure than on a southern exposure in a rate x time of nitrogen application study. Split applications of nitrogen improved total yield, and yield distribution of bluegrass. More than 90% of the nitrogen applied over a 3-year period was recovered in bluegrass hay growing on a north-facing slope as compared to less than 45% recovery on the south-facing slope. Crude protein content of forage varied with rates of nitrogen from 13% with no nitrogen to as much as 25% with 600 lb/acre of N. Yields from residual nitrogen were higher in some cases on the southern exposure than on the northern exposure 1 year after nitrogen applications were stopped because of less growth during previous years.

Title: EFFECTS OF SLOPE INCLINATION AND ORIENTATION ON YIELD AND WATER USE OF FIVE FORAGE SPECIES

Leaders: O. L. Bennett, E. L. Mathias, P. E. Lundberg and G. A. Jung, West Virginia

Studies over a 4-year period with five forage species on north-south exposures with 35% slopes show that maximum soil temperatures at 1 inch were as much as 40 to 50 F higher on a southern exposure as compared to a northern exposure several times during the year. Soil temperature fluctuations on the southern exposure were considerably greater than on the northern exposure. Early spring growth was greater for all species on the southern exposure but total yield was better on the northern exposure for bluegrass and birdsfoot trefoil. Midland bermudagrass always produced highest total yields on the southern exposure. Midland bermudagrass produced approximately 9 tons of oven-dry forage on the southern exposure as compared to 5.5 tons/acre on the northern exposure. Fescue and crownvetch produced equally well on all exposures, but yield distribution was affected by exposure. Microclimate measurements show that both air and soil temperatures were higher, air movement greater, net radiation, evaporation, and ET rates higher, and available soil moisture lower on the southern exposure than on the northern exposure.

Title: SURVIVAL OF RHIZOBIA FROM CROWNVETCH (CORONILLA VARIA L.) IN FERTILIZER-WATER MIXTURES

Leaders: R. W. Duell, R. W. Pace and P. M. Halisky, New Jersey

The slow establishment of crownvetch on roadsides may be due, in part, to poor inoculation. Roadsides are commonly sown with hydroseeders containing complete fertilizers. A quantitative study of a strain of Rhizobium known to nodulate crownvetch was conducted in the laboratory on sterile media containing fertilizer salts. Multiple dilutions of rhizobia were employed to assure the occurrence of countable numbers for each treatment.

In comparison with rhizobia in compatible media, survival in a typical hydroseeder solution (350 lb 10-20-10 in 750 gal water) for 20 min (a typical time requirement) was reduced to 2.6%. That the kill of rhizobia was time-related was shown by a 10.9%, and a 40.4% survival for 10 and 5 min exposure periods, respectively, in the same solution. Similarly, reducing the concentration of the standard fertilizer solution to 1/2 and 1/4 increased rhizobial survival after 20 min exposure to 4.4, and 6.9%, respectively.

Individual salts providing N, P and K at rates comparable to the above fertilizer solution were tested in buffered media for the standard

period. Ammonium nitrate, ammonium phosphate monobasic and potassium chloride, all buffered to pH 6.5 resulted in rhizobial survivals of 73.4, 34.7, and 56.0%, respectively. When the standard complete fertilizer was buffered to pH 6.5, 27.5% of the rhizobia survived, in comparison with a compatible check.

Title: CROSS-INOCULATION STUDIES WITH CROWNVETCH RHIZOBIA

Leaders: P. M. Halisky, R. W. Pace and R. W. Duell, New Jersey

Cross-inoculation studies with Coronilla varia L., Coronilla parviflora Willd. (= C. globosa), and 11 cultures of Rhizobium were conducted using a seedling-inoculation technique. Surface-sterilized seeds of crownvetch were germinated in sterile incubation dishes, inoculated by dipping the roots in a rhizobial suspension, and transferred to individual glass tubes containing nitrogen-free seedling agar. (See Ham, G. E. and L. R. Frederick. 1966. Agron. J. 58:592-599.) The inoculated seedlings in single tubes were grown under fluorescent light (14 hr/day) for 28 days and scored for effective nodulation. Compatible combinations between Coronilla and Rhizobium produced effective nodules and vigorous, green seedlings. Incompatible combinations, on the other hand, resulted in seedlings devoid of nodules showing poor growth, chlorosis and early death.

The results presented in the table show that seven rhizobial cultures originally isolated from Coronilla varia produced effective nodules on this host. In contrast, three cultures originating from Coronilla parviflora and Coronilla cretica L. failed to nodulate C. varia. These data indicate that C. varia probably is strain specific. C. parviflora, on the other hand, was effectively nodulated by nine cultures of rhizobia originally isolated from three species of Coronilla. This evidence suggests that C. parviflora probably is not strain specific.

Cross-inoculation trials with two species of *Coronilla* and eleven *Rhizobium* cultures.

Source of culture*	Host species origin	*Coronilla*-*Rhizobium* compatibility	
		C. varia	*C. parviflora*
1. Australia	*C. parviflora*	-	+
2. New Jersey	*C. parviflora*	-	-
3. Maryland	*C. cretica*	-	+
4. Illinois	*C. varia*	+	+
5. Virginia	*C. varia*	-	-
6. Virginia	*C. varia*	+	+
7. Virginia	*C. varia*	+	+
8. North Dakota	*C. varia*	+	+
9. Commercial	*C. varia*	+	+
10. Commercial	*C. varia*	+	+
11. Commercial	*C. varia*	+	+

* Cultures 3-11 were obtained from Dr. Dean Weber, U.S. Department of Agriculture, Beltsville, Maryland 20705.

Section V

Utilization, Nutritive Evaluation, Pasture, Hay and Silage

Title: REGIONAL PROJECT NE-24 -- THE NUTRITIVE EVALUATION OF FORAGES

Leader: J. L. Evans, Chairman, Regional Technical Committee

Cooperators: The Agricultural Experiment Stations of the 12 Northeastern States; the U.S. Regional Pasture Research Laboratory; the Dairy Cattle Research Branch, ARS; and the Cooperative State Research Service, USDA

Research conducted prior to 1967 by members of NE-24 was directed primarily toward utilization. For example, the decline in digestibility with advancing maturity or date of harvest has been established for first growth of several of the common perennial forages. Work on regrowth forage has indicated that the decline in digestibility as a function of time to be more gradual than that for first growth. Some species and varieties within species have shown different rates of decline in digestibility relative to time for first growth forage. Nitrogen fertilization of grasses has generally resulted in higher protein levels, and timing of the application seems to be critical.

In terms of experimental techniques, the digestibility trial has been evaluated and standardized, chemical and artificial rumen procedures have been used to determine the digestibility of forages, and the Van Soest analyses have been determined to be more precise than those determined by the Weende system.

Research since 1967 has continued on digestibility; however, an increasing emphasis has been placed on voluntary intake. Among the major factors shown to influence the digestibility and the voluntary intake of forage, the following have been under investigation since 1967 -- (a) growth stage and maturity, (b) species and variety of forage, (c) level and type of fertilization and herbicides, (d) method of harvesting and storage, (e) effects of concentrate supplementation, and (f) effects of chemical and physical composition of the diet.

The preliminary work on voluntary intake has shown the assay animal to introduce more variation than has been the case for digestibility. Much more research is needed to define the various animal factors as well as feed factors that regulate or influence voluntary intake. Differences in

digestibility cover less than a two-fold range while differences in voluntary intake cover more than a three-fold range, i.e., digestibility ranges from 40 to 80% of ration dry matter and voluntary intake from 1 to 4% of body weight. As nutritive value of a feedstuff may be represented best as the product of level of voluntary intake and utilization by the animal, voluntary intake plays a significant part in animal performance. Thus, it is concluded that more intensive research is needed to evaluate the many factors that influence voluntary intake and in turn animal performance.

Title: THE NUTRITIVE EVALUATION OF FORAGES (VOLUNTARY INTAKE)

Leaders: J. L. Evans, Z. Nomani and M. A. Garces, New Jersey

The voluntary dry matter intakes of lower-fiber rations supplemented with urea or corn gluten nitrogen were studied. Nitrogen from each of the two sources and from a mixture of the two sources were supplied at four different levels (12 different rations) in the rations of growing steers.

Preliminary data suggested that voluntary dry matter intake was reduced for both sources of nitrogen when the nitrogen in the ration dry matter exceeded 2.4%. On these rations, plasma urea ranged from 4 to 21 mg per 100 ml. Blood was taken one hour after feeding, and the plasma urea values tended to be inversely related to voluntary intake.

Title: THE NUTRITIVE EVALUATION OF FORAGES (RUMINATION)

Leaders: J. G. Welch, A. M. Smith and R. T. Wetherbee, Vermont

Feeding single doses of 40 g or more of urea to rams caused cessation of rumination for periods up to 12 hr. Post-feeding dosing was more effective than pre-feeding dosing. Polypropylene ribbon was shown to have a higher rumination potential than the cell-wall constituent content of straw or hay, in cattle. In particle size studies it was found that 1 cm polypropylene ribbon was passed from the rumen of Jersey steers either in its original ingested form or reduced particle size, indicating the reticulo-omasal oriface will accept particles of at least 1 cm in length. Attempts were made to associate rumination activity with ruminal pH, with no positive results. Feeding molasses to sheep caused a cessation of rumination. Attempts to show the same reaction in cattle were not successful. Placing bits in the mouths of rams for 14 hr to inhibit rumination did not significantly affect appetite.

Rumination equivalent of Polypropylene Ribbon

Mature lactating cows.

Rumination time per gram	
CWC from grass hay	Polypropylene Ribbon
.113 min/g	2.052 min/g

One gram of polypropylene was the equivalent of 17.8 g CWC or 32 g hay.

Polypropylene particle passage

days	1-2	3-4	5-6	total
g rec.	2.05	4.38	3.38	9.81
g unchewed	.55	.22	0.00	.77

Estimated net passage of 50 g doses - 1.5% as unchewed material.

Intake of forages continues to be a most important aspect of forage utilization. The results of the rumination studies will be used in formulating feeding practices based on inducing the greatest rate of passage and forage intake potential.

Rumination investigations will continue including (1) particle size passage studies, (2) effects of specific nutrients on rumination, and (3) rumen environment effects on rumination.

Title: ABSORPTION OF AND INTERRELATIONSHIPS AMONG FAT SOLUBLE VITAMINS

Leader: W. J. Pudelkiewicz, Connecticut (Storrs)

Two compounds have been isolated from alfalfa lipids which lower the tocopherol (vitamin E) levels of chick plasma and liver tissue. One of these compounds, when fed in a standard tocopherol chick diet at levels of 12.5 and 200 ppm caused a decrease in liver tocopherol of 30 and 70%, respectively, when compared with a control diet. From the physical and chemical properties of this compound, it appeared to be a porphyrin-type structure, possibly a breakdown product of chlorophyll. The second compound, structurally, also appeared to be a porphyrin-type compound. Both compounds exerted their effect on both tissue and plasma tocopherol levels by altering or inactivating tocopherol in the feed and gut. Since unesterified tocopherol only was affected by these compounds, it was postulated that hydrolysis of dietary tocopherol esters must occur by an intestinal mucosal esterase just prior to absorption.

Interrelations among the fat soluble vitamins were studied to a limited extent. High levels of dietary vitamin A were shown to have a detrimental effect on vitamin E levels in tissues. Phytol, was also shown to have a detrimental effect on plasma tocopherol levels. Grossly, high levels of vitamin E appeared to enhance hemorrhaging in chicks on low vitamin K levels but no acceptable method was developed to show this analytically. Histologically, there was an indication of increased muscular dystrophy in the chicks consuming diets that contained high vitamin E and low vitamin K levels. This finding was not pursued and this entire project has now been terminated.

Title: EFFECTIVE USE OF BLUEGRASS-WHITE CLOVER HILL PASTURES

Leaders: G. C. Anderson and L. R. Stevens, West Virginia

Six 1.4 acre hill pastures with a northerly exposure and a similar number with a southerly exposure are involved. Pastures are located at an elevation of 1800 ft. Low soil temperatures and high soil moisture delayed grazing of the northern slope pastures. Grazing days for southern and northern slope pastures were 100 and 87 with steer body weight gains of 314 and 286 lb per acre respectively, at a stocking rate of 3 steers per pasture.

Combinations of both types of hill pasture with meadow areas of orchardgrass, Ky 31 tall fescue or bluegrass are being studied to determine the limit of systems for producing year-long food supply and net income.

Title: BEEF CATTLE PERFORMANCE AS RELATED TO FORAGE, GENETIC AND PHYSIOLOGICAL VARIANTS

Leaders: L. L. Wilson, J. B. Washko and A. L. Haskins, Pennsylvania

Lactation stage and quarter affected ($P < .01$) somatic cell count and CMT in milk samples from 44 Angus-Holstein F_1 cows. Calving status and calf sex effects were nonsignificant. Minor pathogenic infections were noted. Body dimensions of 178 steers and 174 heifers from 26 sires were of low heritability. Sire effects on linear and area measurements of metacarpals and metatarsals of 133 cattle by 11 sires were of moderate importance. Bone dimensions were positively related to growth and cutability. Feeding rations containing apple wastes with dieldrin and total DDT of 0.14 and 1.61 ppm to steers indicated that these wastes could

constitute approximately 50% ration DM and result in 1.5 ppm DDT in carcass fat. Activated carbon fed with the waste reduced fat DDT by 24%. Carbon did not increase decontamination rate. Dry matter yields of pastures fertilized with 100 lb of N (50/50)/acre ranged from 3.55 to 5.11 T/acre. Yield differences of Kentucky bluegrass, orchardgrass, smooth bromegrass, reed canarygrass and birdsfoot trefoil were non-significant. Tall grasses with birdsfoot furnished 159 days grazing/acre; orchardgrass and bluegrass furnished 144 and 122 days grazing/acre, respectively.

Title: THE SELECTION AND MANAGEMENT OF FORAGE SPECIES FOR HORSES

Leaders: J. B. Washko and T. L. Merritt, Pennsylvania

Highest dry matter yields were obtained on the alfalfa-Kentucky bluegrass-smooth bromegrass-timothy sward, 3.36 T/acre. Yield differences among the same three grass mixtures with 50/50/50 or 50/50 lb of nitrogen/acre or with birdsfoot trefoil were not significantly different, 2.80, 2.77 and 2.35 T/acre, respectively. The grass sward with 200 lb of N (50/50/50/50) furnished the most grazing days/acre/season when stocked with a mare and foal on 1/2 acre paddocks, 165 days. Similarly the alfalfa-grass and low N rate 100 lb (50/50)/acre furnished 151 and 154 grazing days per season. The birdsfoot trefoil-grass sward had the lowest carrying capacity, 137 grazing days/acre, per mare and her foal.

Mares and foals responded satisfactorily on all plots. However, foals grazed with their mothers on the Kentucky bluegrass-smooth bromegrass-timothy mixture gained more rapidly, 2.81 lb/day, than those on the other plots. Those on the Kentucky bluegrass-smooth bromegrass-timothy-alfalfa mixture gained least, an average of 2.50 lb/day. All mares, except those on the grass-alfalfa plots, lost weight. Average weight loss was 18 lb/mare for the grazing period.

Title: NUTRITIVE VALUE OF CROWNVETCH AS SILAGE AND PASTURE

Leaders: T. A. Long, J. B. Washko and L. L. Wilson, Pennsylvania

On June 23, 1970, one year after planting, 10 acres of Penngift crownvetch in 1/3 bloom were cut with a forage harvester. Stand yield was estimated at 2 tons of dry matter per acre. The forage was ensiled as haylage containing 50% dry matter. Approximately 1-1/2 months later Hereford steers grazed the aftermath.

A grazing study, a sheep metabolism study and a steer feeding trial were used to measure digestibility and acceptability of the crownvetch. Alfalfa haylage was used as a control in the dry lot feeding and metabolism trials. Laboratory tests revealed that on a dry matter basis the crude protein value for crownvetch was 19%, and for alfalfa, 15.5%. Yet, amino acid profiles for the two haylages were essentially identical. The dry matter digestibility coefficients were 51.6 for alfalfa and 46.1 for crownvetch. Two lots of 8 Hereford steers, fed either haylage free-choice and ground shelled corn at 0.5% of body weight, gained more than 1.5 lb daily. Specifically, the group fed crownvetch gained 1.62 lb daily and the alfalfa treatment produced 1.78 lb.

Thirteen Hereford steers, averaging 638 lb in body weight, grazed the 10-acre stand from August 14 until October 2, 1970. Water and salt were provided free choice. Throughout the 54-day period the steers gained 2.45 lb daily and were noticeably getting fat. The effect of this stocking rate and grazing intensity upon the stand remains to be determined in the summer of 1971.

Title: SILAGE INVESTIGATIONS (ALFALFA)

Leader: M. A. Sprague, New Jersey

Experiments underway are designed to determine the degradation and retention of carbohydrate and amino acid feed nutrients as influenced by near-freezing storage temperatures and carbon dioxide enriched atmospheres. These are compared with different higher temperature regimes and storage in air. Such control mechanisms of bacterial and fungi growth have in previous trials improved efficiency of storage with orchardgrass treated with different levels of nitrogen fertilizer. Alfalfa cut in November is currently being used as a test crop.

Title: EFFECT OF N-FERTILIZATION AND MATURITY OF BROMEGRASS ON YIELD, PLANT COMPOSITION AND SILAGE FERMENTATION

Leaders: H. Fenner and W. G. Colby, Massachusetts

Pure stands of bromegrass fertilized with N at 0, 35, 70, 105 and 175 kg/ha were cut at six stages of maturity and at five corresponding aftermaths growth. The latter was treated with 70 kg/ha N uniformly applied to all five plots after removal of the forage of the first growth. Harvested forages were analyzed for yield, contents of common feed nutrients,

fructose, magnesium, calcium, potassium and total buffer capacity. Aliquots of each forage sample were ensiled in quart-sized mason jars, stored for 90 days at constant temperature (22 C) and subsequently maintained at 4 C until analyzed for changes and losses in nutrients and for products of fermentation origin.

In all harvests taken before the early bloom stage, dry matter yields were directly related to N-fertilization. In the early bloom and milk stages of maturity highest yields were obtained from the 70 and 35 kg/ha N fertilized plots, respectively. Highest total dry matter yield from first growth and aftermath combined was obtained from the cutting at the early bloom stage and fertilization rate of 70 kg/ha N.

Corresponding to N-fertilization, linear increases occurred in the contents of crude protein, true protein, ash, calcium and magnesium and curvilinear increases in ether extracts and potassium. Increased N-fertilization lowered linearly the proportion of true protein in crude protein, the contents of N-free extract, crude fiber and fructose and in curvilinear form the forage dry matter. Increased maturity raised the content of dry matter and lowered the proportions of crude protein, true protein, ether extract, ash, calcium, magnesium and potassium. Contents of N-free extract and fructose declined to their lowest concentrations at the boot and the early head stages, respectively, and increased thereafter to their highest levels at the milk stage of maturity.

The results of forage yield and composition will be correlated with nutrient composition, losses and products of fermentation origin.

Title: EFFECTS OF FERTILIZATION OF ORCHARDGRASS ON THE NUTRITION AND REPRODUCTIVE PERFORMANCE OF EWES

Leaders: R. L. Reid, G. A. Jung and Amy J. Post, West Virginia

A long term study was begun in 1967 to determine the effects of four fertilization treatments (56 kg N/ha; 168 kg N/ha; 504 kg N/ha; 504 kg N/ha + Zn, Cu, Mo, Co, S) on the nutritional and reproductive performance of a flock of ewes maintained on an all-forage diet (pasture spring through fall, hay in winter). In the first two lambings (1968, 1969) little effect of fertilizer treatment on the birthweight of lambs was noted; in subsequent lambings (1970, 1971) the birthweight of single lambs and total lambs per ewe has been higher on the low and medium N treatments than on the high N and high N + micro-element treatments. The incidence of goiter on the high nitrogen treatments was high in the first year's lambs, but the occurrence of enlarged thyroids in later lamb crops has been sporadic. Iodine supplementation of ewes in 1969-1970 significantly lowered thyroid gland weights, percentage I-131 uptake and

follicular cell height in newborn lambs, indicating that the iodine status of the ewes was marginal. Studies on serum and liver levels of vitamin A have indicated no marked effect of nitrogen fertilization on vitamin A storage; there has been an annual increase in the concentrations of liver vitamin A in the ewes.

Variations in pasture and serum mineral concentrations have been recorded throughout the study. In 1970 it was observed that young goats raised on the high nitrogen + micro-element treatment showed clinical symptoms of copper deficiency. Copper supplementation of the grazing ewes gave no significant serum copper or ceruloplasmin response on any fertilizer treatment, although it was noted that the ceruloplasmin activity of ewes on the low nitrogen treatment was consistently lower than that of other groups. In each year of the trials, however, the serum and liver copper concentrations of weanling (4 month) lambs raised on pasture with their dams were significantly lower in the low and high nitrogen + micro-element treatments. Liver Cu stores of the micro-element lambs were extremely low, and it was concluded that these animals were subclinically copper deficient.

Intake and digestibility trials carried out with lactating and dry ewes on pasture in 2 years of the study indicated (a) no differences in dry matter digestibility due to fertilizer treatment or condition of the ewe, (b) significant differences in level of intake due to fertilizer treatment and to condition of the ewe. In both years, the intake of dry matter by ewes on low and medium N fertilizer herbage was greater than on high nitrogen treatments. Intake of herbage by lactating ewes was greater than intake by dry animals.

Title: EFFECTS OF DOLOMITIC OR CALCIC LIME AS SOIL AMENDMENTS AS JUDGED BY PLANT MAGNESIUM LEVEL AND SERUM MAGNESIUM OF EWES GRAZING THE PASTURE IN THE SPRING

Leaders: D. J. Horvath and R. F. Keefer, West Virginia

Lime was applied to the surface of four soils: Gilpin, Ernest, Cookport, and Lakin, based on lime requirement determinations and neutralizing equivalence of the material.

The soils ranged from a C.E.C. of 7.5 to 20.0 meq/100 g and supported stands of orchardgrass. Two years after application, there was a significantly greater spring forage Mg level with dolomite, but the increase was so small that supplemental magnesium would still be recommended for the animals at this time.

Forage zinc was not significantly altered and, with a range of 15-35 ppm, would be considered marginal to deficient. Forage sodium was similarly deficient for animals.

In the second year, there were significantly fewer hypomagnesemic ewes (serum Mg< 1.5 mg %) on the dolomite treated Gilpin soil ($P < .05$) and a similar trend was noted on the domomite treated Ernest soil ($P < .10$) as compared to the calcic treated plots.

It is assumed that an additional 2 years will be required to properly evaluate the effects of topdressed dolomite. It does appear at this date, however, that C.E.C. is not an adequate basis for predicting forage Mg level following application.

Title: INFLUENCE OF SOIL FERTILIZATION ON THE NUTRITIVE VALUE OF CORN AND ALFALFA

Leaders: N. A. Clark and B. A. Schneider, Maryland

Two experiments were established to study the influence of various fertility combinations on the mineral and cell wall components of corn and alfalfa. The first experiment tested combinations of N, K, Mg and Ca on corn. While the second experiment was conducted using six alfalfa varieties and three rates of K. Phosphorus levels were held constant in both experiments. Results with corn indicated that Ca was associated with high cell walls, acid detergent fiber and cellulose but low silica contents. Potassium was generally associated with higher digestibile dry matter (DDM), but silica accumulated under K treatments. Ear-stover ratios were highest under Mg treatments. No fertility element was consistently correlated with lignin. Potassium decreased P, Ca and Mg concentrations in alfalfa. Calcium was negatively correlated with cell walls and positively with DDM. Alfalfa yields were not affected by K applications, but K did reduce the severity of leafspot and anthracnose diseases.

Title: RELATIVE EFFECTIVENESS OF FALL VS. SPRING APPLICATION OF NITROGEN FERTILIZER IN CORN SILAGE PRODUCTION

Leader: R. W. Wengel, Connecticut (Storrs)

A four-year field experiment was conducted to determine the relative effectiveness of fall applied nitrogen compared to spring applied nitrogen on corn silage production using yield and nitrogen content of the plant tissue as measures of treatment effects.

Time of fall nitrogen application was determined by soil temperature at the 4-inch soil depth. When maximum soil temperature was not greater than 45 F, fall nitrogen was applied in the form of urea. At this time, spring and fall plots received phosphorus and potassium fertilization as well. All plots were then fall plowed. Spring application of nitrogen was made within one week of planting and all plots were disked at this time for seedbed preparation.

Two fields were used in the course of the experiment; one for the first two years and a second for the last two years.

In all years there was no significant difference due to time of application between yields or percentage of N (Kjeldahl-N) at comparable levels of spring and fall nitrogen applications. Nitrogen levels were lowered in an attempt to magnify treatment effects. The range of nitrogen applied was 150-300 lb N/acre the first two years and 100-250 lb N/acre the second two years. Significant response to nitrogen level was obtained in the first, third and fourth years. Check yields (0 nitrogen) were 69% and 44% of the maximum yields in the last two years which were 29.0 and 30.4 tons 30% DM silage, respectively.

Title: STATUS REPORT ON NO-TILLAGE CORN PRODUCTION IN CONNECTICUT

Leaders: R. A. Peters and W. M. Dest, Connecticut (Storrs)

A cooperative effort was made in 1970 between the University of Connecticut and three area Extension Dairy Specialists to interest dairy farmers in growing silage corn commercially by no-tillage methods. The Specialists assisted the growers in obtaining no-tillage planting equipment, in making specific recommendations upon request on herbicide treatments, and in one area of the state by actually assisting in the planting operation. Approximately 1600 acres of no-tillage corn were planted with generally satisfactory results.

Herbicide treatments varied but most involved paraquat plus atrazine. Vegetation control was generally satisfactory, however, control of dandelions and quackgrass was erratic.

Lack of uniform stands was found at several locations. This is related to poor seed placement by the no-tillage corn planter and/or greater insect injury than found in conventional seedbeds.

In a long term experiment at Storrs, second-year corn silage yields on no-tillage plots were the same as yields on plowed, conventional plots.

Surface application of a complete fertilizer applied after planting was effective. Corn roots were observed growing close to the soil surface

where the fertilizer was concentrated. If applied prior to planting, however, the fertilizer on the soil surface was thrown aside by the fluted coulter of the no-tillage planter resulting in poor corn seedling growth. Banding of phosphorus fertilizer with the seed is suggested.

Title: SOD SEEDING OF CORN AND SILAGE SPECIES

Leaders: O. L. Bennett, E. L. Mathias, P. E. Lundberg and E. K. Inskeep, West Virginia

Studies were conducted in which sheep were utilized to graze sod planted corn and sudax as compared to grazing fertilized and unfertilized orchardgrass. Gains of more than 1200 lb/acre were produced in 22 days of grazing sod planted sudax in a rotational system. This was compared to approximately 150 lb/acre from fertilized orchardgrass and 80 lb/acre in unfertilized orchardgrass in 24 days. Sheep grazing sod planted corn utilized up to 77% of the total dry matter produced. When sheep were forced to eat the entire stalk of corn before removal, they lost an average of 550 lb/acre. However, when sheep ate only the grass and lower leaves of the corn, they gained an average of 330 lb/acre. Grazing the lower leaves of corn reduced yield by approximately 25 bu/acre; however, yields were still approximately 100 bu/acre on the grazed corn. The permanent sod planted to sudax and corn was making regrowth at the end of the growing season.

Title: MANAGEMENT OF ANNUAL FORAGE SPECIES FOR QUALITY FORAGE

Leaders: J. B. Washko, W. G. Downs and J. O. Yocum, Pennsylvania

Hybrid corn was the most productive of dry matter at two locations in the state when compared with 16 sorghum-sudan hybrids, 5 sudangrasses and one hybrid pearl millet. Pennsylvania corn hybrids 604, 8703 and 8705 produced 10.41, 11.69 and 12.68 T/acre of dry matter that could be used for greenchop or silage. The highest yielding sorghum-sudangrass hybrid was Sweet Sioux averaging 8.71 tons of dry matter per acre. Sweet Sioux, Grazer A, Pioneer 988, Kow-Dan H202 and ST-6 were the 5 most productive sorghum-sudan hybrids. H6853 and HS-33 were the most productive sudangrass hybrids.

Among the winter annuals Redcoat and Pennoll wheats were the most productive of forage. Tetra Petkus rye was next highest yielding. Field bromegrass was superior to domestic ryegrass in forage production. In

central Pennsylvania highest forage yields of field bromegrass were obtained with seedings made during the period August 1 to August 22. Early September seedings were lowest yielding. No advantage in forage yield was obtained on this species with 100 lb N/acre applied at seeding compared with 50 lb of N.

Title: DOUBLE-CROPPING BARLEY AND CORN FOR FORAGE USING NO-TILLAGE CORN PLANTING

Leader: L. Hoffmann, Maryland

The study was designed to compare forage yields from corn for silage; barley for silage followed by corn for silage; and barley for grain followed by corn for silage using both no-tillage and conventional planting.

The study is underway at the University Forage Research Farm, Clarksville, Maryland.

Title: NUTRITIVE EVALUATION OF FORAGES (CORN SILAGE)

Leaders: J. B. Holter and N. F. Colovos, New Hampshire

In Experiment I the corn plant was harvested at four stages of kernel maturity and fed at two levels of intake to four Holstein steers and, simultaneously to four wethers. Level of intake was considered to be a split plot applied in time within a 4 x 4 Latin square. Experiment II was similar to Experiment I except that only steers were used and they were fed slightly less than an ad libitum level of intake; also, the silages were somewhat higher in dry matter and a different supplement was used.

Twelve lactating Holstein cows were used during mid-lactation in Experiment III. Corn silage was offered ad libitum in a continuous trial; hay was limited to 0, 0.5 or 1.0% body weight (treatment variable) and concentrate was fed according to production (NRC). Traits which were significantly influenced by level of energy intake were adjusted for differences in energy intake.

Increasing the level of intake of maize silage significantly reduced its NE value, principally as a result of increased HI energy loss. The NE value of maize silage DM in Holstein steers was calculated to be

1.42 Mcal/kg at a rate of DM intake of 2.0 kg/100 kg body weight. The data suggests that the type of supplement fed, even in small quantities, with maize silage substantially influences the NE value of the total ration, perhaps through its associative effect. Further evidence suggests that sheep utilize more mature mature maize silages with greater efficiency than cattle.

Substituting dry hay for maize silage in a mixed ration fed to lactating dairy cattle was found to reduce fecal energy loss and increase methane energy loss significantly. When maize silage was fed as the sole forage, milk energy yield was higher, though not significantly so, and body energy retention was lower than when hay replaced part of the silage in the ration.

Title: NUTRITIVE VALUE OF LIVESTOCK FEEDS PRESERVED AND STORED AS SILAGE

Leaders: J. B. Washko and E. M. Kesler, Pennsylvania

Four silage crops produced the following amounts of dry matter in T/acre; Pa hybrid 510 corn 9.16, Grazer A sorghum-sudangrass hybrid 8.85, Trudan 4 hybrid sudangrass 6.94 and Piper 4.58. Except for the corn, the first harvest of each crop is to be evaluated for milk production in 1971 feeding trials. During the winter of 1970 early cut corn (25.4% dry matter) and late cut corn (35.9% DM) were fed to lactating Holstein dairy cows as silage. Average daily intake of silage dry matter was 19.3 and 19.4 lb/acre/day. Cow performance on the two silages was similar. The major advantage in delaying harvest was that it allowed greater accumulation of dry matter/acre before ensiling, approximately 1100 lb.

Title: CORN SILAGE VS. CORN SILAGE AND HAY FOR LACTATING DAIRY CATTLE

Leader: J. B. Holter, New Hampshire

Thirty dairy cows fed 0, 0.5 or 1.0 kg hay/100 kg BW along with corn silage (CS) ad libitum and concentrate to production averaged, during a 4-yr trial, 5731, 6118 and 5560 kg milk/262 days, respectively. Corresponding milk fat percentages were 3.04^{b}, 3.36^{a} and 3.38 ($a > b$, $P < .05$). Cows receiving CS as the sole forage ate less forage and less total feed dry matter than those receiving some hay. Milk SNF and protein increased with increasing hay in the ration. Solids-corrected milk yield at the 0.5 kg level was significantly higher than for the other two

treatments. Milk yield per unit forage dry matter was greatest for cows receiving no hay. Although the experiment was not designed to measure the effects of proportion of CS in the diet on herd health, cows fed no hay generally had less incidence of health-related disorders, lower turnover rate and higher reproductive efficiency. Results when published (1971), will be of substantial practical value to dairymen, particularly in areas where CS is a predominant forage for dairy cattle.

Title: SOME EFFECTS OF ADDING PRESERVATIVES AND ENSILING BLIGHT INFECTED CORN

Leaders: B. R. Baumgardt, Lester Burdette, Herbert Cole, Jr. and T. A. Long, Pennsylvania

In this study the effects of adding chemical preservatives and ensiling were noted on a severely blighted Pioneer hybrid. The blight organism was H. maydis. Evaluations were made using a microscope and lamb feeding trial.

Five tons of infected corn chop were secured from a farm in Lancaster County, Pennsylvania and divided into one ton segments, four of which were treated with one of the following: Compound A, containing calcium formate and calcium nitrate; formic acid; sodium meta bisulfite; or Compound B, containing fumaric acid, sodium benzoate and sodium propionate. Each treatment received 8 lb of preservative per ton. A one ton batch received no treatment and one ton of uninfected corn was ensiled. Small metal silos, 4' x 8', housed the treatments.

A microscopic examination of blighted corn chop prior to ensilement showed the propagules of a wide range of fungal genera, a condition that was drastically altered by ensilement alone, or in combination with added preservative. Compound A, sodium meta-bisulfite, and Compound B treatments caused the greatest reduction in viable fungal propagules.

Following 7 weeks of ensilement, 6 lots containing 8 lambs each were fed one of the silages free choice, along with 20% crownvetch 1/2-inch pellets. Lambs accepted all rations similarly; consumption ranged from 3 3 to 3.8 lb/head/day. In general, adding preservative chemicals to infected chop at ensilement caused improved gains and feed efficiencies; in particular, Compound B and formic acid treated silages produced the best responses. As expected, all treatments produced low gains (about 0.1 lb) because the rations fed in this trial were designed to test the feeding value of blighted corn silage and to place maximum emphasis upon the silage rations.

Title: EFFECT OF *HELMINTHOSPORIUM MAYDIS* ON QUALITY COMPONENTS OF CORN GROWN FOR SILAGE

Leaders: D. W. Allinson and W. W. Washko, Connecticut (Storrs)

In 1970 corn fields in Connecticut were affected by southern corn leaf blight. Paired samples of relatively diseased and nondiseased Indiana 654 plants were obtained. These samples were fractionated into tassel, upper and lower stems, upper and lower leaves, husks, ears, and cobs and then dried and ground. Tissues were analyzed for quality parameters.

Diseased fractions were significantly lower in percentage of crude protein and *in vitro* dry matter digestibility and higher in percentage of cell wall constituents, acid detergent fiber, and acid detergent lignin. Diseased stem fractions were especially higher in structural components compared to nondiseased fractions.

Title: INCOME EFFECTS OF INCREASING THE RELATIVE SUPPLY OF FORAGE DERIVED FROM CORN SILAGE ON CONNECTICUT DAIRY FARMS

Leader: Irving F. Fellows, Connecticut (Storrs)

A survey of 19 selected Connecticut dairy farms obtained data on corn silage production practices. A weighted mean of 13.25 man-hours was required to grow, harvest, and store silage. When a standard cost of $1.50 per hour was used for labor, the weighted mean total cash costs were $110 per acre. A production function was developed to show the response in tons of dry matter of corn silage to fertilizer components and levels, and plant population per acre.

Using the functional data and adjusting crop production practices, the potential production of therms of energy was estimated for representative farms. Adjustments were then planned in livestock, labor and capital inputs to utilize the available forage energy and the net income effects were estimated. Substantial increases were realized on all representative farms.

LIST OF PUBLICATIONS

Akhavein, A. A. and D. L. Linscott. 1970. Effects of paraquat and light regime on quackgrass growth. Weed Sci. 18:378-382.

Allinson, D. W. and D. F. Osbourn. 1970. The cellulose-lignin complex in forages and its relationship to forage nutritive value. J. Agr. Sci. (Cambridge) 74:23-36.

_____ and R. A. Peters. 1970. Influence of simazine on crude protein and cellulose content and yield of forage grasses. Agron. J. 62: 246-250.

Anderson, G. C., C. Veatch, J. Newman and W. Gillespie. 1971. Control of brush in pastures with aerial herbicide application. West Va. Agr. Exp. Sta. Bull. 598.

Armstrong, K. C. and R. W. Cleveland. 1970. Hybrids of Trifolium pratense X Trifolium pallidum. Crop Sci. 10:354-357.

Baker, Barton S. and G. A. Jung. 1970. Nucleic acid concentration of four perennial grasses grown at various day-night temperature combinations. Crop Sci. 10:376-378.

_____ and G. A. Jung. 1970. Response of four perennial grasses to temperature stress. Proc. 11th Int. Grassl. Congr., Queensland, Australia, p. 499-502.

Barnes, D. K., C. H. Hanson, R. H. Ratcliffe, T. H. Busbice, J. A. Schillinger, G. R. Buss, W. V. Campbell, R. W. Hemken, and C. C. Blickenstaff. 1970. The development and performance of Team alfalfa: A multiple pest resistant alfalfa with moderate resistance to the alfalfa weevil. ARS 34-115, 41 p.

_____ and M. G. Stephenson. 1971. Relative efficiencies of four self-pollination techniques in alfalfa. Crop Sci. 11:131-132.

Barnes, R. F. and G. O. Mott. 1970. Evaluation of selected clones of Phalaris arundinacea L. I. In vivo digestibility and intake. Agron. J. 62:719-722.

_____, W. E. Nyquist and R. C. Pickett. 1970. Variation in acceptability and covariation with agronomic characters in Phalaris arundinacea L. Proc. 11th Int. Grassl. Congr. Queensland, Australia, p. 202-206.

Blickenstaff, C. C., W. L. Harris, N. A. Clark, A. L. Steinhauer, J. W. Neal and R. M. Coan. 1971. Flaming and cultural treatments for alfalfa weevil control in Maryland. Maryland Agr. Exp. Sta. Bull. A171.

Bock, H. R. and J. B. Washko. 1970. Forage production found similar on several soils. Sci. in Agr. 18 (1):6.

Braverman, S. W. 1971. Myrothecium leaf spot of birdsfoot trefoil. Phytopathology 61:127 (Abstr.)

Bull, L. S., J. T. Reid and D. E. Johnson. 1970. Energetics of sheep concerned with the utilization of acetic acid. J. Nutr. 100:262-276.

Burns, J. C., R. F. Barnes, W. F. Wedin, C. L. Rhykerd and C. H. Noller. 1970. Nutritional characteristics of forage sorghum and sudangrass after frost. Agron. J. 62:348-350.

Campbell, J. K. and W. F. Miller. 1971. An investigation of tedding upon field drying of alfalfa. Res. Rept. 16 p. Illus. (Reprints available from authors)

Carlson, G. E., R. H. Hart, C. H. Hanson and R. B. Pearce. 1970. Overcoming barriers to higher forage yields through breeding for physiological and morphological characteristics. Proc. 11th Int. Grassl. Congr. Queensland, Australia, p. 248-251.

Carroll, R. B. and F. L. Lukezic. 1970. Preservation of single-cell isolates of Corynebacterium insidiosum in sterile soil without loss of virulence. Phytopathology 60:1287 (Abstr.)

_____, F. L. Lukezic and J. M. Skelly. 1970. Evidence that isolates of Sclerotinia trifoliorum from crownvetch and alfalfa are not specific for either host. Plant Dis. Reptr. 54:811-814.

Chen, Sherry and D. L. Linscott. 1971. Tank mixtures of dinoseb-dalapon versus split applications. Proc. NE Weed Sci. Soc. 25:309.

Clark, N. A. 1970. Pros and cons of summer annuals. Amer. Forage Grassl. Council. 3rd Ann. Res. Industry Conf. Chicago, Ill.

Colovos, N. F., J. B. Holter, R. M. Koes, W. E. Urban, Jr. and H. A. Davis. 1970. Digestibility, nutritive value and intake of ensiled corn plant (Zea mays) in cattle and sheep. J. Animal Sci. 30:819-824.

Cubillos, G. F., R. F. Barnes, C. H. Noller, D. Cerviño and F. Ortiz. 1970. Effect of plant age on the chemical composition and in vitro dry matter digestibility in ryegrass, Lolium perenne L. (In Spanish, English summary) Agricultura Técnica (Chile) 30:1-6.

Decker, A. M. 1970. More forage per acre with Midland bermudagrass. Southern Planter 126:6-7, 14.

_____. 1970. Produce feed more efficiently. Better Crops 54:6-9.

Dinius, D. A., J. F. Kavanaugh and B. R. Baumgardt. 1970. Regulation of food intake in ruminants. 7. Interrelations between food intake and body temperature. J. Dairy Sci. 53:438-445.

_____ and B. R. Baumgardt. 1970. Regulation of food intake in ruminants. 6. Influence of caloric density of pelleted rations. J. Dairy Sci. 53:311-316.

Dunn, G. M. and J. A. Wright. 1970. Performance of diallel crosses of Bromus inermis for forage yield. Crop Sci. 10:56-58.

_____ and M. Nasiruddin. 1971. Cytogenetics of a temperature-sensitive albino mutant in smooth bromegrass (Bromus inermis Leyss.) Crop Sci. 11:208-211.

Elgin, J. H., Jr., R. R. Hill, Jr. and K. E. Zeiders. 1970. Comparison of four methods of multiple trait selection for five traits in alfalfa. Crop Sci. 10:190-193.

Fenner, H. and R. A. Damon, Jr. 1969. Relationship of some inorganic rumen fluid components to ration composition and time of sampling after feeding. J. Dairy Sci. 52:937 (Abstr.)

_____, R. A. Damon, Jr. and H. D. Barnes. 1969. The interaction of pH concentration of volatile fatty acids and dissolved cations in the rumen of the bovine. Proc. 8th Int. Congr. Nutr. Prague, Czechoslovakia, p. 178.

_____, R. A. Damon, Jr. and H. D. Barnes. 1970. Effect of a stepwise replacement of hay by corn silage on pH, some organic metabolites and their changes after feeding in the rumen fluid of the bovine. J. Dairy Sci. 53:1568-1577.

Hagin, R. D., D. L. Linscott and J. E. Dawson. 1970. 2,4-D metabolism in resistant grasses. J. Agr. Food Chem. 18:848-850.

Hamlen, R. A., F. L. Lukezic and J. R. Bloom. 1970. The influence of age on neutral carbohydrate components in root exudates from alfalfa plants grown in a gnotobiotic environment. Phytopathology 60:1294 (Abstr.)

Hanson, C. H. 1970. Variety concepts in change. Proc. 16th Ann. Farm Seed Conf. Kansas City, Mo. p. 31-41.

_____ and O. J. Hunt. 1970. Overcoming barriers to higher forage yields and quality of alfalfa through breeding for resistance to disease and insect pests. Proc. 11th Int. Grassl. Congr. Queensland, Australia, p. 263-266.

Hanson, C. H. and R. H. Ratcliffe. 1970. The alfalfa weevil menace: Is relief in sight? Crops and Soils 23 (1):10-12.

Hemken, R. W., N. A. Clark, H. K. Goering and J. H. Vandersall. 1971. Nutritive value of corn silage as influenced by grain content. J. Dairy Sci. 54:383-389.

Hill, R. R., Jr., M. W. Pedersen, L. J. Elling, R. W. Cleveland, J. H. Graham, F. I. Frosheiser and J. L. Starling. 1971. Comparison of expected genetic advance with selection on the basis of clone and polycross progeny-test performance in alfalfa. Crop Sci. 11:88-91.

Holter, J. B., N. F. Colovos and W. E. Urban, Jr. 1970. Energy utilization in the ruminant fed maize silages as the sole forage. European Assoc. Animal Prod. EAAP Publ. 13, p. 33-36.

Howell, R. K., T. E. Devine and C. H. Hanson. 1971. Resistance of selected alfalfa strains to ozone. Crop Sci. 11:114-115.

Husain, A., C. S. Chen and J. T. Clayton. 1970. Coupled heat and moisture diffusion in porous food products (an application to rough rice drying). Paper no. 70-833 Amer. Soc. Agr. Engin. Meeting. Chicago, Ill.

Karue, C. N., J. L. Evans and J. G. Welch. 1970. Metabolism of urea nitrogen and adaptation response trends in the growing wether and steer. East African Agr. and Forestry J. 36:88-93.

Kendall, W. A., R. H. Lowe and N. L. Taylor. 1971. Growth of red clover pollen. III. Free amino acid composition in grains and supplements to culture media. Crop Sci. 11:112-114.

_____, J. R. Todd and W. C. Templeton. 1969. Simplification of the dry matter disappearance technique to estimate forage quality. Crop Sci. 10:47-48.

Leath, K. T. 1971. Quality of light required for sporulation by Leptosphaerulina. Phytopathology 61:70-72.

Linscott, D. L. 1970. Quackgrass [control in crops]. Crops and Soils 23(1):8-9.

_____ and R. D. Hagin. 1970. Additions to the aliphatic moiety of chlorophenoxy compounds. Weed Sci. 18:197-198.

_____ and R. D. Hagin. 1971. Herbicides for weed control in seedling red clover and birdsfoot trefoil. Proc. NE Weed Sci. Soc. 25:309.

_____ and R. D. Hagin. 1971. Establishing crownvetch for seed production. Proc. NE Weed Sci. Soc. 25:295.

_____, R. D. Hagin and M. J. Wright. 1970. Dalapon residues in alfalfa as affected by harvesting and dehydrating. Agron. J. 62:405-407.

Lyford, S. J., Jr., H. Fenner and W. Colby. 1970. Glucosidase and galacturonase activity of silages prepared from orchard and brome grasses grown at different levels of N-fertility. J. Dairy Sci. 53:678 (Abstr.)

McKee, G. W. and M. L. Risius. 1970. Varietal differences in crown-vetch cotyledon size. Agron. J. 62:711-714.

Mears, D. R. and W. J. Roberts. 1970. Methods of accelerating forage drying. Trans. Amer. Soc. Agr. Engineers 13:531-533.

_____, W. J. Roberts, M. E. Singley and G. H. Nieswand. 1971. Radial folded plate roof for a circular dairy barn. Amer. Assoc. Agr. Engin., Trans. (in press).

Millier, D. E. and G. L. Jensen. 1970. Agromyzid alfalfa leaf miners and their parasites in Massachusetts. J. Econ. Entomol. 63:1337-1338.

Muehlbauer, F. J., H. G. Marshall and R. R. Hill, Jr. 1970. Winter hardiness in oat populations derived from reciprocal crosses. Crop Sci. 10:646-649.

Neal, J. W., Jr. and W. E. Bickley. 1971. A study of Microctonus aethiops (Nees), a Braconid parasite of the alfalfa weevil, Hypera postica (Gyllenhal). Maryland Agr. Exp. Sta. Scientific Article No. 1668, 62 p.

_____, W. E. Bickley and C. C. Blickenstaff. 1970. Recovery of the Braconid parasite Microctonus aethiops from the alfalfa weevil after hormonal treatment. J. Econ. Entomol. 63:681-682.

_____, W. T. Hollaway and W. E. Bickley. 1971. Response of Microctonus aethiops and M. colesi, parasites of the alfalfa weevil to a mixture of cis-trans- and trans-trans-10,11-epoxyfarnesenic acid methyl ester. J. Econ. Entomol. 64:338-339.

Newton, D. L., W. A. Kendall and N. L. Taylor. 1970. Hybridization of some Trifolium species through stylar temperature treatments. Theoret. Appl. Genet. 40:59-62.

Newton, R. C. and R. R. Hill, Jr. 1970. Use of caged adult forage insects to determine their comparative roles in delaying the re-growth of alfalfa. J. Econ. Entomol. 63:1542-1543.

_____, R. R. Hill, Jr. and J. H. Elgin, Jr. 1970. Differential injury to alfalfa by male and female potato leafhoppers. J. Econ. Entomol. 63:1077-1079.

Okorie, A. U., R. W. Hemken and J. A. Schillinger. 1970. Nutritive evaluation of alfalfa varieties. J. Animal Sci. 31:215 (Abstr.)

Peters, R. A. and W. M. Dest. 1970. Seed treatment and incorporation as factors influencing annual grass control in corn, 1970. NE Weed Control Conf. Proc. 25:39-41.

_____ and S. Dunn. 1971. Life history studies as related to weed control in the Northeast: Large and small crabgrass. NE Regional Publ. Bull. 415.

Ratcliffe, R. H. and T. E. Devine. 1970. The development and performance of Team alfalfa. (Talk presented at 15th Forage Insects Res. Conf. Urbana, Ill.)

Reeder, R. C., R. G. Diener and K. C. Elliott. 1970. Design and development of an extra-wide swath fertilizer spreader. ASAE Paper No. 70-656.

Reid, J. T. 1970. The future role of ruminants in animal production. p. 1. In A. T. Phillipson (ed.) Physiology of digestion and metabolism in the ruminant. Oriel Press.

Reid, R. L., Amy J. Post and G. A. Jung. 1970. The nutritive evaluation of orchardgrass pasture under different levels of nitrogen fertilization. Proc. New Zeal. Grassl. Assoc. (in press).

_____, Amy J. Post and G. A. Jung. 1970. Mineral composition of forages. West Va. Agr. Exp. Sta. Bull. 589T, 35 p.

Schneider, B. A. and N. A. Clark. 1970. Effect of potassium on the mineral constituents of pearl millet. Agron. J. 62:474-477.

Schroder, R. F. W. 1970. A modified suction machine for sampling populations of the alfalfa weevil on alfalfa. J. Econ. Entomol. 63: 1329-1330.

_____. 1970. Population shifts of the alfalfa weevil. (Talk presented at Joint Meeting of the 22nd Alfalfa Impr. Conf. and 15th Forage Insects Res. Conf. Urbana, Ill.)

Shoemaker, H. D., R. G. Diener and E. C. Dubbe. 1970. Computer design of deflectors on a high speed belt fertilizer spreader. ASAE Paper No. 70-658.

Singley, M. E., W. J. Roberts and D. R. Mears. 1970. Experimental circular dairy barn. Agr. Engin. 51:78-79.

Sprague, M. A. 1970. Present and future trends of grassland research in the United States. Symp. Paper. Proc. New Zeal. Grassl. Assoc. 15 p. (in press)

_____ and B. B. Taylor. 1970. Forage composition and losses from orchardgrass silage as affected by maturity and nitrogen fertilization. Agron. J. 62:749-753.

Washko, J. B. 1970. Alfalfa management. Pennsylvania Farmer 182(3):8.

_____. 1970. Fall harvest management of alfalfa. Forage and Grassl. Prog. 11(3):3-4.

_____. 1970. Put more kick in horse pastures. Pennsylvania Farmer 182(5)14-15.

_____ and J. W. Price. 1970. Intensive management of alfalfa for forage production. Proc. 11th Int. Grassl. Congr. Queensland, Australia, 628-632.

_____, J. W. Price and F. L. Lukezic. 1970. Forage production on alfalfa experiments in Lehigh and Northampton Counties being conducted with the alfalfa dehydration industry and others. Agron. Mimeo. Rept. 12.

_____, R. H. Swain and T. L. Merritt. 1970. Quality horse pasture with fertilized grasses. Sci. in Agr. 17(3):6-7.

Welch, J. G. and A. M. Smith. 1970. Rumination activity from beet pulp and citrus pulp. J. Animal Sci. 31:258 (Abstr.)

_____ and A. M. Smith. 1970. Forage quality and rumination time in cattle. J. Dairy Sci. 53:797-800.

_____ and A. M. Smith. 1970. Polypropylene fibers and rumination activity. J. Dairy Sci. 53:679 (Abstr.)

_____, A. M. Smith and K. S. Gibson. 1970. Rumination time in four breeds of dairy cattle. J. Dairy Sci. 53:89-91.

Wood, G. M. 1970. Shade grasses. Proc. Massachusetts Ann. Turfgrass Conf.

_____. 1970. Shade tolerant grasses of the United States and southern Canada. Proc. 1st Int. Turfgrass Res. Conf. Harrogate, England.

_____ and P. A. Kingsbury. 1969. Seedling emergence and survival of several cool season grasses subjected to induced drouth stress. Agron. Abstr. p. 56.

Name	Institution	Advisor	Thesis title
M.S. Degree			
Baluch, S. J.	Penn. State Univ.	M. L. Risius	The behavior of pollen tubes in situ of Coronilla varia L. cv. 'Penngift'
Banchero, C. B.	Cornell Univ.	R. P. Murphy	Cytoplasmic male sterility in a cultivar of alfalfa, Medicago sativa L. 'Saranac'
Berchtold, D. K.	Penn. State Univ.	R. W. Cleveland	Meiosis in two cultivars of Coronilla varia L.
Carneiro, A. M.	Penn. State Univ.	J. B. Washko	The effect of seeding dates and nitrogen levels on the yield of field bromegrass, Bromus arvensis
Cuevas-Ortega, S.	Cornell Univ.	J. T. Reid	Ruminal concentration of volatile fatty acids in lambs fed freshly harvested pasture forage
Patel, Ashok	Rutgers Univ.	M. E. Singley	Development of a forage-feed planning model for the Rutgers dairy herd: An activity analysis approach
Petrie, J. G.	Cornell Univ.	D. Q. Thompson J. T. Reid	The effects of cage density and simulated cover on food utilization and other processes in the meadow vole (Microtus pennsylvanicus)
Valdivia, Ricardo	Cornell Univ.	J. T. Reid	Estimation of forage digestibility under grazing conditions

Name	Institution	Advisor	Thesis title
Ph.D. Degree			
Burton, J. H.	Cornell Univ.	J. T. Reid	The efficiency of energy utilization and changes in adipose tissue during periods of growth, weight reduction and realimentation in sheep
Horn, F. P.	West Va. Univ.	R. L. Reid	Iodine nutrition and metabolism in grazing sheep
Nasiruddin, M.	Univ. New Hampshire	G. M. Dunn	Genetics of an albino mutant in smooth bromegrass (Bromus inermis Leyss)
Neal, J. W., Jr.	Univ. Maryland	W. E. Bickley	A study of Microctonus aethiops (Nees), a Braconid parasite of the alfalfa weevil, Hypera postica (Gyllenhal)
Robb, James	Cornell Univ.	J. T. Reid	Energetic efficiency of utilization of acetic acid and glycerol in fattening sheep
Thomson, Sandra M.	Univ. Conn.	W. J. Pudelkiewicz	Resolution of the problem of tissue tocopherol depressing factors present in alfalfa lipids
Torres, Filemon	Cornell Univ.	J. T. Reid	Efficiency of utilization of forage energy by grazing and hand-fed lambs